NEW ENGLAND WATER WORKS ASSOCIATION.

ORGANIZED 1882.

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This Association, as a Body, is not responsible for the statements or opinions of any of its members.

QUARTERLY MEETING.

YOUNG'S HOTEL, BOSTON, MASS., December 12, 1894.

The following members and guests were present :

ACTIVE MEMBERS.

Everett L. Abbott, New York City ; Charles H. Baldwin, Boston, Mass.; Lewis M. Bancroft, Reading, Mass.; Charles H. Bartlett, Manchester, N. H.; George E. Batchelder, Worcester, Mass.; Joseph E. Beals, Middleboro, Mass.; George Bowers, Lowell, Mass.; Dexter Brackett, Boston, Mass.; Arthur W. F. Brown, Fitchburg, Mass.; George F. Chace, Taunton, Mass.; E. J. Chadbourne, Wakefield, Mass.; John C. Chase, Wilmington, N. C.; Freeman C. Coffin, Boston, Mass.; H. W. Conant, Gardner, Mass.; Byron I. Cook, Woonsocket, R. I.; F. H. Crandall, Burlington, Vt.; George E. Crowell, Brattleboro, Vt., Horace L. Eaton, Somerville, Mass.; Harrison P. Eddy, Worcester, Mass.; George E. Evans, Boston, Mass.; B. R. Felton, Marlboro, Mass.; Charles R. Felton, Brockton, Mass.; F. F. Forbes, Brookline, Mass.; Frank L. Fuller, Boston, Mass.; George W. Fuller, Lawrence, Mass.; J. A. Gould, Jr., Boston, Mass.; Frank E. Hall, Quincy, Mass.; George W. Harrington, Wakefield, Mass.; John L. Harrington, Cambridge, Mass.; David A. Hartwell, Fitchburg, Mass.; John C. Haskell, Lynn, Mass.; V. C. Hastings, Concord, N. H.; William B. Hawes, Fall River, Mass.; Allen Hazen, Lawrence, Mass.; Clemens Herschel, New York City; James H. Higgins, Providence, R. I.; Horace G. Holden, Nashua, N. H.; Daniel D. Jackson, Newtonville, Mass.; James A. Jones, Stoneham, Mass.; Joseph

L. Kenney, Lewiston, Me.; Patrick Kieran, Fall River, Mass.; George A. Kimball, Boston, Mass.; Horace Kingman, Brockton, Mass.; Thomas C. Lovell, Fitchburg, Mass.; William J. Luther, Attleboro, Mass.; William McNally, Marlboro, Mass.; James W. Morse, Natick, Mass.; Thomas Naylor, Maynard, Mass.; Edward C. Nichols, Reading, Mass.; Frank L. Northrop, Milford, Mass.; Albert F. Noyes, Boston, Mass.; John H. Perkins, Watertown, Mass.; Edward H. Phipps, New Haven, Conn.; Waldo E. Rawson, Uxbridge, Mass.; George S. Rice, Boston, Mass.; Walter H. Richards, New London, Conn.; George J. Ries, Weymouth Centre, Mass.: W. W. Robertson, Fall River, Mass.; Henry W. Rogers, Haverhill, Mass.; A. H. Salisbury, Lawrence, Mass.; Caleb M. Saville, Malden, Mass.; H. O. Smith, Leicester, Mass.; Solon F. Smith, Grafton, Mass.; Robert J. Thomas, Lowell, Mass.; William H. Thomas, Hingham, Mass.; M. M. Tidd, Boston, Mass.; D. N. Tower, Cohasset, Mass.; W. H. Vaughn, Wellesley Hills, Mass.; Charles K. Walker, Manchester, N. H.; William F. Williams, New Bedford, Mass.; Frederic I. Winslow, Boston, Mass.; George E. Winslow, Waltham, Mass.; E. T. Wiswall, West Newton, Mass.

HONORARY MEMBER.

F. W. Shepperd, New York City.

ASSOCIATE MEMBERS.

C. W. Houghton, Ashton Valve Co., Boston, Mass.; James M. Betton, Boston, Mass.; H. K. Dalton, Jr., Chapman Valve Manufacturing Co., Indian Orchard, Mass.; F. H. Hayes, Deane Steam Pump Co., Holyoke, Mass.; George A. Taylor, Gilchrist & Taylor, Boston, Mass.; S. Harrison, Hersey Manufacturing Co., South Boston, Mass.; Henry T. Jenks, Pawtucket, R.I.; B. G. Russell, third Secretary P eet Valve Co., Boston, Mass.; H.L. Bond, Perrin, Seamans & Co., Boston, Mass.; W. H. Van Winkle, A. P. Smith, Newark, N. J.; F. J. Dibble and I. W. Dodge, Standard Thermometer Co., Peabody, Mass.; S. D. Higley, Thomson Meter Co., Brooklyn, N. Y.; B. F. Polsey, Walworth Manufacturing Co., Boston, Mass.

GUESTS.

A. W. Barnes, Fitchburg, Mass.; Charles L. Bentley, Boston, Mass.; E. W. Bush, Waterbury, Conn.; Louis P. Collins, Lawrence, Mass.; Hon. William N. Davenport, Marlboro, Mass.; George Haskell, Marlboro, Mass.; William E. Hawks, Bennington, Vt.; C. F. Holyoke, Marlboro, Mass.; F. A. Houdlette, Boston, Mass.; J. F. Halloway, New York City; J. W. Locke, Brockton, Mass.; J. W. McDonald, Marlboro, Mass.; Henry L. Parsons, Marlboro, Mass.; George E. Putnam, Lowell, Mass.; J. B. Reith, Peabody, Mass.; S. H. Taylor, New Bedford, Mass.; George E. Stanley, Lowell, Mass.; Prof. Riley and Sligo Quartette, Marlboro, Mass.

Total attendance, 111.

Applications for membership, approved by the Executive Committee, were received from the following named persons :

RESIDENT ACTIVE.

Thomas McKenzie, Civil Engineer, Providence, R. I.; Lewis P. Collins, Water Commissioner, Lawrence, Mass.; Charles W. Mann, Water Commissioner, Methuen, Mass.; John Walker, Civil Engineer, Newmarket, N. H.; William E. Hawkes, of Bennington, Vt., President and Treasurer of the Leadville Water Works Co., Colorado, Raton Water Works Co., New Mexico, and Monroe Water Works and Electric Light Co., Texas.

NON-RESIDENT ACTIVE.

A. E. Foye, Civil Engineer, Instructor in Civil Engineering, Columbia College, 41 East 49th Street, New York City ; C. B. Beason, Civil Engineer, 71 Wall Street, New York City.

ASSOCIATE.

Peck Brothers and Co., Water Works Supplies, 65 Oliver Street, Boston, Mass.; The Snow Steam Pump Works, Steam Pumps, 106 Liberty Street, New York City.

On motion of Mr. Holden the Secretary was instructed to cast the ballot of the Association for the applicants, and they were declared elected.

The Secretary read the following communication from the Association of Engineering Societies, Philadelphia :

Mr. R. C. P. Coggeshall, Secretary New England Water Works Association:

DEAR SIR—For the mutual advantage of your Society and of the Association of Engineering Societies, we desire to call your attention to the methods of the latter, and to solicit your co-operation in its work.

The Association was organized in 1881, "in order to secure a joint publication of the papers and transactions of the participating societies."

At the time it embraced four societies, viz.: The Boston Society of Civil Engineers, the Western Society of Engineers, the Civil Engineers' Club of Cleveland, and the Engineers' Club of St. Louis. Since then the Engineers' Club of Kansas City, the Engineers' Club of Minneapolis, the Montana Society of Civil Engineers and the Civil Engineers' Society of St. Paul have joined the Association. Our monthly journal since the appearance of its first number, in November, 1882, has steadily grown, until, in 1893, the twelfth annual volume comprised 657 pages of text, and 211 pages of the Index of Current Technical Literature, which forms so important a part of the publication. This index is published monthly in the Journal, and is annually re-compiled under one alphabetical arrangement and re-issued to each member of the participating societies. The expenses of publishing the Journal are met by quarterly assessments upon the several societies, in the ratio of their respective memberships.

We send you by this mail a number of sample copies of the Journal, so that your members may acquaint themselves with the character of the publication, both as to the material published and as to the manner of its presentation.

Please note that your membership in the Association need in no wise interfere with your separate publication of your own papers and proceedings, for, after such papers have been printed for the Journal, any desired number of reprints can be made from the same type, and these reprints can be laid aside, to be furnished to you at any desired intervals, and bound in any desired form as your own transactions, at no further cost than that of the additional paper, presswork and binding. This expense will, of course, be very light as compared with that of independent publication. Hence, if you already enjoy a considerable advertising patronage, most of this could be devoted to the payment of your assessments. You will notice also the very important point that by this method of co-operation your papers are given a very much wider circulation than is otherwise possible.

The Association will furnish, also, to any of the societies desiring them, advance copies of any papers submitted. Here, also, the additional expense on such papers as afterward appear in the Journal, is only that of paper and presswork.

Every reader of engineering literature must have deplored the multiplication of separate engineering periodicals and must have desired that as many as possible of these should be merged into one. It is this office which the Association of Engineering Societies has undertaken to perform.

The advantages of co-operation in the matter of publishing the papers of engineering societies are so manifest that it is scarcely necessary to enumerate them, but chief among them is that of economy, for with a given style of production, such work can, of course, be done more economically in large than in small quantities.

Thus far, however, the number of societies participating is inconsiderable when compared with the number of important local, state and sectional societies in the country; and, hence, notwithstanding the economy due to the measure of co-operation already effected, our assessments at present amount to about $3.00 per annum for each member of the participating societies. For this each member receives, however, not merely the papers and transactions of his own society, but those of the other societies in the Association, together with the valuable Index of Current Literature already mentioned. It is believed that if all or most of the important societies join the Association, the assessments upon the members of the societies can be reduced, if not to zero, at least to a nominal figure, not only by reason of reduction of the cost of publication, but also and especially because a Journal containing the transactions of practically all of the important engineering societies of the country must command the subscription of every engineer who wishes to keep abreast of the times, and the advertising patronage of every enterprising furnisher of articles used by engineers.

If, therefore, such general co-operation can be effected, we confidently look to the attainment of much greater advantages than can be secured by the accession of any one society.

Please bring this matter to the attention of your members at the next meeting of your society, and get, if possible, some expression as to the desirability of your society's joining a general movement of this kind if it can be effected.

This will enable our Board of Managers to issue a second circular letter to the societies not now in the Association, informing them how the matter is viewed by the other societies.

It is understood that any provisional expression of opinion sent to the undersigned, in response to this circular, will not commit your society in any way, but will indicate what will probably be the disposition of your society in case it is found practicable to unite the other outside societies in the movement.

Whatever action is to be taken should be taken before the beginning of the next fiscal year, and it is therefore hoped that this provisional expression of opinion will be rendered as soon as possible.

By order of the Board of Managers,

JOHN C. TRAUTWINE, Secretary.

On motion of Mr. Chase, the communication was referred to the executive committee with instructions to investigate the matter and report at the next meeting.

Mayor Davenport, of Marlboro, was introduced by President Stacy, and made a short address.

Mr. Allen Hazen read a paper entitled, "Notes on Foreign Water Supplies." Mr. Herschel, Mr. Brackett and Mr. Noyes took part in the discussion which followed the reading of the paper.

The members were entertained with several songs rendered by the Sligo Quartette.

Adjourned.

ADJOURNED MEETING.

YOUNG'S HOTEL, BOSTON, MASS., January 9, 1895.

The following members and guests were present:

ACTIVE MEMBERS.

Charles H. Baldwin, Boston, Mass.; Lewis M. Bancroft, Reading, Mass.; George E. Batchelder, Worcester, Mass.; Joseph E. Beals, Middleboro, Mass.; William R. Billings, Taunton, Mass; George Bowers, Lowell, Mass.; Dexter Brackett, Boston, Mass.; Arthur W. F. Brown, Fitchburg, Mass.; George F. Chace, Taunton, Mass.; John C. Chase, Wilmington, N. C.; E. W. Clarke, Boston, Mass.; William F. Codd, Nantucket, Mass; R. C. P. Coggeshall, New Bedford, Mass.; Byron I. Cook, Woonsocket, R. I.; Albert B. Drake, New Bedford, Mass.; Charles E. Drake, New Bedford, Mass.; Horace L. Eaton, Somerville, Mass.; B. R. Felton, Marlboro, Mass.; F F. Forbes, Brookline, Mass.; Z. R. Forbes, Brookline, Mass.; Julius C. Gilbert, Whitman, Mass,; W. J. Goldthwait, Marblehead, Mass.; J. A. Gould, Jr., Boston, Mass.; John L. Harrington, Cambridge, Mass.; John C. Haskell. Lynn, Mass.; Louis Hawes, Boston, Mass.; William B. Hawes, Fall River, Mass.; T. G. Hazard, Jr., Narragansett,

Pier, R. I.; Allen Hazen, Lawrence, Mass.; Horace G. Holden, Nashua, N. H.; Joseph L. Kenney, Lewiston, Me.; Willard Kent, Woonsocket, R. I.; Patrick Kieran, Fall River, Mass.; George A. Kimball, Boston, Mass.; Charles W. Mann, Methuen, Mass.; Thomas Naylor, Maynard, Mass.; Edward C. Nichols, Reading, Mass.; John H. Perkins, Watertown, Mass.; Walter H. Richards, New London, Conn.; A. H. Salisbury, Lawrence, Mass.; Caleb M. Saville, Malden, Mass.; George A. Stacy, Marlboro, Mass.; James H. Stanwood, Boston, Mass.; Lucian A. Taylor, Boston, Mass.; Robert J. Thomas, Lowell, Mass.; William H. Thomas, Hingham, Mass.; D. N. Tower, Cohassett, Mass.; W. N. Vaughn, Wellesley Hills, Mass.; Charles K. Walker, Manchester, N. H.; Joseph Watters, Fall River, Mass.; John C. Whitney, West Newton, Mass.; George E. Winslow, Waltham, Mass.; Horace B. Winship, Norwich, Conn.; E. Worthington, Jr., Boston, Mass.

ASSOCIATE MEMBERS.

James M. Betton, Boston, Mass.; A. H. Broderick, Chadwick Lead Works, Boston, Mass.; E. L. Ross, Chapman Valve M'f'g Co., Indian Orchard, Mass.; Z. E. Coffin and F. E. Adams, Coffin Valve Co., Boston, Mass.; F. H. Hayes, Deane Steam Pump Co., Boston, Mass.; H. N. Libbey, Gilchrist & Taylor, Boston, Mass.; S. Harrison, Hersey M'f'g Co., South Boston, Mass.; S. B. Adams and B. G. Russell, Peet Valve Co., Boston, Mass.; H. L. Bond, Perrin, Seamans & Co., Boston, Mass.: Franklin A. Snow, Providence, R. I.; Rodney Thayer, Snow Steam Pump Works, Brooklyn, N. Y.; H. B. Temby, Boston, Mass.. S. D. Higley, Thomson Meter Co., Brooklyn, N. Y.; J. P. K. Otis, Union Water Meter Co., Worcester, Mass.; W. E. Newhall, R. D. Wood & Co., Philadelphia, Penn.; H. A. Gorham, The George Woodman Co., Boston, Mass.

GUESTS.

F. C. Gifford, Waltham, Mass.; J. W. Locke, Brockton, Mass.; W. E. McKay, Boston, Mass.; Charles L. Medden, San Francisco, Cal.; J. W. Milne, Fall River, Mass.; F. G. Perry, Pawtucket, R. I.; George Putnam, Lowell, Mass.; Thomas H. Rogers, Nashua, N. H.; George E. Stanley, Lowell, Mass.; S. H. Taylor, New Bedford, Mass.

Total attendance, 82.

The meeting was called to order by President Stacy at 2.15 o'clock, p. m.

Secretary Coggeshall announced the following applications for membership, which had been approved by the Executive Committee; James W. Locke, foreman, Brockton, Mass.; Harley, E. Royce, assistant engineer, Brookline, Mass.; Henry D. Woods, city engineer, West Newton, Mass.

It was voted that the Secretary cast one ballot for the said applicants, and the Secretary, having performed that duty, declared that they were severally elected members of the Association.

Secretary Coggeshall submitted the following report from the Executive Committee:

Regarding the proposition from the Association of Engineering Societies for

a joint publication of proceedings, it is the opinion of the Executive Committee that it will not be advisable for the Association to accept the proposition.

The report was accepted, and the recommendation adopted.

RESIGNATION OF SECRETARY R. C. P. COGGESHALL.

THE PRESIDENT. Gentlemen, I now have a duty to perform, in reading the document which I hold in my hand, that is in some respects a sad one and is a more disagreeable duty than I hope I shall be obliged to again perform during the remainder of my term of office. When you know the contents of this letter, you will appreciate the feelings of deep regret of myself and of everybody else, who has the welfare of this Association at heart :

To the Officers and Members of the New England Water Works Association:

GENTLEMEN. With the exception of a single year I have had the honor of being a prominent member of the Executive Committee of this Association ever since the date of organization in June, 1882.

First I served you as Secretary, then as President, Senior Editor, and in June, 1887, I again took up the work of Secretary which position I have filled continuously up to the present time.

During this time the Association has grown from a small organization to a large and influential society.

With such continuous growth and prosperity there naturally comes an addition to the cares and responsibilities of the routine duties of your Secretary.

Meanwhile another official position which I hold, and which is rather more important to my daily welfare, requires more time now than formerly. These facts, together with the added responsibilities of a work incidental to a new construction of a large magnitude, leaves me with no time to give your affairs such attention as they ought to have. Thus I am compelled to make a choice between the two positions.

I feel very grateful to the members of this Association in being selected by you year after year as your Secretary, and the duties of the position have given me a great deal of pleasure, so that it is with feelings of deep regret that I am obliged to place my resignation as Secretary in your hands, and request, as a kindness to me, that steps may be taken as soon as possible to relieve me of all its duties.

I thank all the members for the many acts of kindness shown me, and assure you that I shall always look back to my term of service in the New England Water Works Association with many pleasant memories.

Very respectfully,

R. C. P. COGGESHALL.

THE PRESIDENT. Gentlemen, you hear the resignation of our Secretary. What action is it your pleasure to take in regard to the matter?

MR. RICHARDS. Mr. President, I will offer a motion to this effect:

Voted, That the resignation of the office of Secretary by R. C. P. Coggeshall be accepted, and that the Association proceed to elect a Secretary pro tem.

In presenting this motion I would say that I do it with more reluctance than almost anything I have ever done in my life. I don't know that this is the time or place to eulogize Secretary Coggeshall. I don't think I could do it satisfactorily if I should attempt it. You all know what Mr. Coggeshall has been to this Association. You know that its success has been very largely the result of his efforts. And I think that almost every one of the members—certainly the older members—have a strong personal regard for him.

But Mr. Coggeshall insists that this resignation is irrevocable, for reasons that it is not necessary to mention here, and I therefore offer the motion.

MR. BILLINGS. Mr. President, in one sense of the word I may say that I take pleasure in seconding the motion, and yet you all understand what I mean when I say that. No one can have listened to that letter of resignation, and the necessary acceptance of it, which is embodied in the motion of Mr. Richards without regretting that the necessity for it has arisen. But I am informed that the necessity is a real one and that we cannot let our wishes or feelings interfere with the course which the matter must take.

My association with Mr. Coggeshall during the last few years, in so far as association matters go, has not been as intimate as I could wish. That has been because it must be so, not because we wished it so. I look back with the greatest pleasure to the time when we were working together in the early days of the association.

I know you will not forget at this time, gentlemen, that Mr. Coggeshall was largely instrumental in preparing that form of statistics, which we now use, and which, after several years' use, was taken up by a new committee to see if they could make any changes. That committee were kind enough to say that they saw no opportunity for improvement except that the members should use it more freely.

Mr. Coggeshall was directly interested as senior editor and in the first number of the Journal which was issued, and the general form of the Journal, cover, title page, and so on, has not been changed since that first number. To Mr. Coggeshall belongs a full share of the credit for that Journal.

It is not long ago that at one of our meetings I sat next to a gentleman somewhat prominent in the scientific world, a member of other societies, and he said to me: "Why is it that the New England Water Works Association has such vigorous and long-continued life? Is there some secret about it? At any rate, whatever the cause may be, I can bear witness to the fact that there are many older associations that would be glad to get hold of the cause of the life and vigor which this association shows." I was glad to say to him at that time, without attributing it wholly to any one cause, that by no means the least cause, was the faithful and thorough work of the secretary.

I don't know that anything more need be said, Mr. President. The only thought that occurs to me that if the time shall ever come when this association shall see fit to make the office of secretary a permanent one, one of larger scope and with larger salary, I trust that in choosing the man to fill the place they will be able to secure one equal in ability and faithfulness to the gentleman whose resignation we now so reluctantly accept. (Applause.)

The motion was adopted.

It was voted on motion of Mr. Batchelder, duly seconded, that Mr. Dexter Brackett be elected Secretary pro tem of this Association, and that a committee of five, of which the President shall be one, the other four to be appointed by the President, shall nominate a candidate for permanent secretary of the association and report at the next meeting.

The committee appointed consisted of Messrs. Batchelder, Richards, Noyes and Brackett.

Mr. Coggeshall. Gentlemen, I thank you very much for doing as I have indicated, and I only hope that the time may come when I can be of future service to you. (Applause.)

Papers were presented by Mr. Brackett upon "The Capacity of Steam Fire Engines," Mr. Chace upon "Eternal Vigilance the Price of Good Water," and Mr. Codd upon "A Method of Connecting Lead Services."

The President. I want to impress upon your minds the fact that the opening remarks of Mr. Chace "that either you are too modest or too busy to furnish papers," are very pertinent. While we have a few papers on hand, we should have more, and incidents like these will perhaps help us out one way or another—an account of all the little difficulties we run against during the administration of our business, not only in connection with the actual furnishing of water, but in every part of the business pertaining to water works. Any experience we have had that pertains in any way to the management of water works, either in the pipe lines or in the office, would be of interest here, and interest enough should be taken by the members to write up such incidents. It does not involve much work and the association needs them. We need them for our meetings, we need them for our Journal, we need them to keep things going. I will ask if there is any member here who will promise to contribute for any of our future meetings? If there are any such members I trust that they will notify the secretary to that effect. I wish to say that while we call for these experience papers it does not refer wholly to the superintendents and managers of the outside work. As I have said before, it covers the whole ground. Papers of experience from the office are of as much interest and as instructive as any other papers to us. They are of interest to this Association as interesting as the outside work. So don't think that it is simply the outside management that we wish to hear about. We want to cover the whole ground and to be just as broad as the association.

CONSUMPTION FOR THE YEAR 1894.

MR. BRACKETT. Mr. President, in accordance with the request which was sent with the notices, quite a goodly number of the members have sent in a statement of the consumption for the past year. We have not as yet had time to tabulate the figures or to get them into such shape as to be able to draw any conclusions; but there is one point which I noticed in connection with one of the statements which I would like to have the superintendent explain. The city of Fall River pumped during the last year 890,000,000 gallons. They metered through about 4900 meters 374,600,000 gallons, leaving 515,000,000 gallons, or something over 60 per cent. of the total, which was used by the following people, who are not metered, but pay annual rates. These appear to be all the fixtures in use there which do not pay meter rates—1530 faucets, 33 hose connections, 1 bath tub, 52 water closets, 84 horses and 7 cows. It strikes me that those people must use a great deal of water, if they use 60 per cent. of all the water that is used in the city.

MR. KIERAN. Mr. President, I would like to explain, that in our city (Fall River) there is no charge for water for public purposes, and that the 60 per cent. is largely used for public purposes, for which we receive no revenue, and but a very small portion for those fixtures which have been referred to. There are somewhere in the neighborhood of fifty schools, which run from 5-inch to 6-inch pipes, a great deal running day and night, no charge for it, and so long as our department does not do the repairs it is cheaper for them to waste water than to have the plumbing repaired. Then there is flushing of sewers, water used for fire purposes and all public purposes. A very small portion of that 60 per cent. is used by those annual takers, for the reason that most all of the takers who pay annual rates are on the outskirts of the town, where they are not connected with sewers and have not over two faucets. Most of the houses connected with sewers, with any number of fixtures, are metered, because 93 per cent. of our revenue is from meter measurement.

MR. BRACKETT. Well, the fact still is that but about 1,000,000 gallons a day is accounted for by meter measurement, and that there is 1,400,000 gallons every day in the year used by the school houses, and other public purposes which appears to me to be a very large proportion.

MR. BEALS. I notice on that circular that we are asked to give the number of gallons per day to each tap. Is that intended to be the whole number of faucets in the system or the taps in the main?

MR. COGGESHALL. Taps in the main.

MR. BEALS. There would, of course, be a great difference in the figures. All of us have many cases where there are two or three families on a tap in the main, and the giving of the gallons per day per faucet would, of course, change the pro rata from the gallons per day to each tap in the main.

MR. HARRINGTON. Do I understand that Mr. Brackett intends to study this matter after the reports are handed in to him and that we are to receive the benefit of that study?

THE PRESIDENT. That is the way we understand it, and I would request those who have not complied with the request which is made upon our circular, to do so at the earliest moment. I think the results will be of some interest to us in studying this question, as showing what the variation is between the works and the consumer, and we will see if we cannot arrive at some definite conclusion in studying a problem, which will help us in reducing the consumption of water or accounting for it. If we were now asked on the spur of the moment why our consumption was larger than that of other places, we would perhaps be unable to tell. With the conditions and everything relating to the problem brought out, I think we would have a great deal of valuable information which we do not possess to-day. So I would urge that the request be complied with. It will take very little trouble to do it, and it seems as though every superintendent could favor us with the returns called for in the last notice in regard to the consumption of water in connection with his works.

MR. RICHARDS. Mr. President, Mr. Brackett every year compiles these figures from the annual reports and they are published in the Journal. Now, as to the conclusions to be drawn from them, it seems to me it is fair for some one else to take those figures and draw the conclusions.

There is another matter which I think that we discuss very little, and that is the business side of water works, if you can so term it. In coming down on the train this morning I happened to have a copy of the Journal with me and it occurred to me that I would see how much water they furnish for one dollar in different places. I did not have time to go through the list, but it ran from 44,000 gallons for one dollar down to 7,000 gallons for one dollar, and it occurred to me that there was a chance for somebody to do a little thinking and to write a paper. There must be some reason for that. That would approach the subject from the business side, and I think the time will come before long when we shall be asked to consider that end of the subject—whether we are making the works pay or not. In fact we had an intimation of that kind from Mayor Matthews, I believe, last June.

MR. BEALS. In the table of statistics which members of the Association are asked to prepare, you ask for the total population and the population on lines of pipe. Now, in the case of Middleborough, our waterworks are owned by a district within the town. We have 65 square miles of territory in the town and the water district comprises about five miles. In the census as taken we have no means of getting at the population of the district. We can judge a little by the voting list that is prepared every year, because it has a separate list prepared for its annual meeting, and in my estimate I have called the population of the district two-thirds of the population of the whole town. That is in the five square miles we have two-thirds of all the inhabitants there are in the 65 square miles, and certainly more than two-thirds of the valuation. But our water supply covers that five miles. There is some outlying territory that is not covered, but it does not include a large population. The district is quite well covered with pipe, and on the line of the pipe there are very few houses that are not connected with the mains. In making up these sta-

tistics, however, there might be a good deal that is misleading, because the comparisons are not alike.

I would like to see how other towns base their work and how the work and statistics of different towns compare one with another. In making such comparisons, of course the bases of the comparisons would have to be taken into consideration.

MR. COGGESHALL. In reply to Mr. Beals I would say that the idea of this circular, when Mr. Billings and I prepared this scheme a good many years ago, was to obtain first the total population, referring to the population of the town and then the population on lines of pipe. For instance, take the city of New Bedford, the total population refers to the total population including the whole outlying district. The second, estimated population on lines of pipe, refers to the population that might be supplied by the lines of pipe in use. Then, third, estimated population supplied, refers of course, to the number of takers.

MR. BEALS. Yes, and the town pays for the whole. In our case the *district* pays the bills.

MR. COGGESHALL. Well, there is a question in your case.

In answer to a question by Mr. Beals, Mr. Coggeshall stated that the amounts for hydrant service, flushing trenches, for drinking fountains, schoolhouses, and all public uses, are considered in the report suggested by the New England Water Works Association, as receipts from public funds, while they are in a sense "for service rendered."

The meeting was adjourned, on motion of Mr. Brackett, at 4.14 o'clock p. m.

ETERNAL VIGILANCE, THE PRICE OF GOOD WATER.

BY

G. F. CHACE, SUPERINTENDENT, Taunton, Mass.

[Read Jan. 9, 1895.]

When I became the executive officer of the Taunton Water Commissioners, in April, 1888, I found the water works in good condition. They had been well managed and many improvements had been made by my predecessor, Mr. Billings.

Except in one particular it remained for me, in conjunction with the commissioners, only to continue the same progressive action which had been working in the past. That particular was the water supply. This, for several years, had been in one way or another unsatisfactory, both to the consumers and to the officials of the water department.

Efforts had been made from year to year to ascertain the cause of existing troubles, to apply remedies and to increase the amount of water available. These efforts had been partly successful; but the results were not wholly satisfactory to any one.

Taking advantage of all that had been previously learned in the history of the department, by experiment and study, I set myself the task, with the hearty and efficient co-operation and support of the commissioners, of solving the problem of a water supply, for Taunton, satisfactory to all parties, both in quality and quantity.

I pass over the preliminary work of four years. In August, 1892, we began to lay a thirty-inch cast iron main to connect our Taunton Pumping Station with Elder's Pond, in Lakeville, the water flowing by gravity from this pond to the Taunton connections with the filter basin and the suction of the engines.

Elder's Pond was known to be too small for a full supply. The intention was to use this colorless pond of 145 acres as a storage reservoir and settling basin, to improve the water of Assowampset Pond, to be pumped in to Elder's. It was thought that the old filter basin might for a time, at least, be utilized for a portion of our daily supply, and no more water be taken from Lakeville than was necessary to make up the deficit of the filter basin, the latter being cut off from all direct connection with the river.

The water of the new supply was first delivered to the consumers of Taunton, on April 5, 1894. At first people were delighted with the change. The water was cold, soft and clear as crystal.

In about a month there began to be complaints of a bad taste and odor. For a few days I attributed this to local causes, such as a dirty service pipe or a dirty meter. But I soon found the cases of bad water to be too numerous and too widespread to be accounted for in this manner. Complaints came from services that were not metered and from those in which the water did not improve by flushing the service. The cause of the trouble was, however, soon obvious.

During the day-time, except on Sundays, the water was supplied to the consumers by the Gaskill engine, the suction of which is connected directly with the pipe line from Elder's, under an average head of 66 feet.

During nights and Sundays water was pumped by the Holly engine, which took water from the old pump well which was connected directly with the filter basin. There is a connection between the filter basin and the Lakeville supply, but this is generally kept closed, as the basin is now constantly full without its help.

Complaints of the quality of the water were most numerous on Mondays, when there had been about 24 hours pumping from the filter basin.

It was evident we had here the same old difficulty which was present in 1883. The river being cut off, and the water of the basin remaining stagnant, the ground water of the basin, exposed to the air and light, was beginning again to develop an excess of microscopic vegetation, which gave rise to a bad taste and a bad odor.

Two remedies were considered. One was periodically to pump out the basin into the river, as could be done by a suitable arrangement of piping, and to refill the basin with water from the Elder's Pond supply. It was feared that this plan would not remove all the trouble, and we concluded to adopt this only for emergencies and to give the city ordinarily nothing but Lakeville water.

To accomplish this a direct connection was made between the pump well and the Lakeville supply, while the gate between the filter basin and pump well was closed.

The well was then pumped out, thoroughly cleaned and refilled with Lakeville water. Both engines thereafter supplied Lakeville water, so that day or night, every day in the week, no other water reached the consumers.

The complaints ceased. I had myself noticed the taste at my own home, but the taste was all right after we had stopped using the basin.

All summer the water continued good. Instead of the grumblings and sarcastic flings in the newspapers of previous summers, the whole city was feeling proud of its supply, and the newspapers were boasting of its excellence.

Sunday, November 25, at supper, I noticed a disagreeable, musty taste to the water. I soon had a telephone message from one of the commissioners who had also discovered something wrong. I told him I would investigate. The result of the investigation revealed the following facts :

About two weeks before, the man who was taking care of the gate house at Elder's Pond had found a live muskrat in the screen chamber. He struck it,

and thought he had killed it ; but it disappeared from view. The water in the chamber is about ten feet deep. He looked all around, but not being able to find the animal, he concluded that it must have revived and gone out into the pond. Nothing more was seen or heard of this rodent until Monday morning, November 26.

I had telephoned the engineer at Assowampset, of the trouble in Taunton, and, at my suggestion, he had sent a man to the Elder's gate house to investigate. The messenger found, floating on the water, and fished out, a dead muskrat. The corpse had not long been on the surface, for I was at the gate house the day before and saw nothing of it, and the screen was cleaned on that day without discovering it. There was a suspicious, musty odor, but I attributed this to the dead air, the house being closed.

As soon as this discovery was telephoned to me, I hastened to the Taunton Pumping Station and tasted of the water at a faucet in the boiler room. I found the vile taste there.

A sixteen-inch blow off into the river affords the means of flushing the whole line of pipe from Elder's Pond. I opened the gate wide enough to produce a good stream of water, but at the same time not wide enough to reduce the suction head of the Gaskill engine more that twenty-five or thirty feet.

This flushing of the pipe from Elder's Pond was continued from 11 a. m. to 4 p. m. The water kept improving in taste during the flushing, and at 4 p. m. the bad quality had disappeared.

As we did not do any flushing up town of the mains, the bad taste lingered in some localities about the city, for several days, but finally departed. Meantime I had explained to anxious enquirers that an accident had happened at the gate house. It would not happen again, and the water would be all right in a few days.

At the screen chamber, in front of the gate opening into the thirty-inch pipe, are two screens of brass wire with one-quarter inch meshes. One or the other of these screens is always down in place. The aforesaid animal had evidently intended, from the grass he had carried in, to make a nest and spend the winter with his mate, who had also been seen in the vicinity, in the screen chamber.

Opening into the screen chamber from the pond side is a thirty-six inch Coffin gate. In the front wall of the gate house foundation is an oblong water way with iron stop plank grooves on either side, to provide opportunity, by means of the stop planks, to shut off the pond when necessary for repairs.

November 27, the day after the flushing, I came to Boston and ordered the wire for a heavy screen to put at this opening of the gate house, in order to keep out unwelcome intruders.

The screen has been placed in position, and is strong enough to withstand the assault of a moderate sized shark.

December 19, our meter inspector showed me something, about two inches long, which he had taken from a Thomson meter, which he had found stopped. He explained he had found another similar thing twisted around the spindle of

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December 19, our meter inspector showed me something, about two inches long, which he had taken from a Thomson meter, which he had found stopped. He explained he had found another similar thing twisted around the spindle of

the disc, and this circumstance undoubtedly caused the stopping. We thought the pieces seemed to be short hairs.

I put the piece he gave me under the microscope with one of my own hairs, this being the only species readily available, and found sufficient similarity of structure to satisfy me, in connection with the surrounding circumstances, that at least two hairs of that Lakeville muskrat had paid a visit to Taunton ; and I was confirmed in my belief that his death and burial in a watery grave had been the cause of our mourning.

Since that occurrence we have had no trouble with the water, and I have no hesitation in declaring that the present water supply of Taunton is not surpassed in quality by that of any city in the Commonwealth. But, if it is true, as Wendell Philips, or some one else, once said, that "Eternal Vigilance is the Price of Liberty," the experience of more than one water works superintendent has taught him that "Eternal Vigilance is the Price of Good Water."

THE CAPACITY OF STEAM FIRE ENGINES, HYDRANTS AND HOSE.

BY

DEXTER BRACKETT, Assistant Engineer, Boston, Mass.

[Read Jan. 9th, 1895.]

In the fall of 1893, a series of tests were made under the immediate supervision of the writer, of the different types and sizes of steam fire engines in use by the Boston Fire Department.

They were made under the direction of the City Engineer, at the request of the Fire Commissioners, who desired to have tests made which would show, as nearly as was practicable, the capacity and efficiency of the engines under the conditions actually occurring at fires.

So far as the writer is aware these tests are the first of the kind which have ever been made, and as a number of the results are intimately connected with questions of water supply, it is thought that a description of the tests may be of interest to the members of this association.

The ordinary method of testing a steam fire engine, by delivering as large an amount as is possible for a few minutes through an open butt into a tank or through a short length of hose, is of very little value in determining the quantity which the same engine will deliver continuously upon a fire through 500 feet of hose and a $1\frac{1}{4}$-inch nozzle.

The general dimensions of the steamers tested are given in the following table:

TABLE No. 1.

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
STYLE OF ENGINE.	Department No.	Maker's No.	When built.	Weight of engine.	Diameter of steam cylinder.	Diameter of pump plunger.	Stroke.	Calculated capacity at 300 revolutions.	Diameter of boiler.	Heating surface in boiler.
				Lbs.	In.	In.	In.	Gals.	In.	Sq. ft.
Amoskeag	36	664	1890	6,950	6.136	4.005	8.00	498	31.5	101.
Amoskeag	D	619	1886	7,150	6.888	4.249	8.00	562	30 5	85.
Amoskeag	14	354	1870	.....	7.662	4.40	7.90	594	31.75	74.
Amoskeag ...	27	415	1872	7,085	7.651	4.50	7.89	619	32.0	86.5
Clapp & Jones	43	566	1893	.....	6 988	4.376	7.00	525	29.5	86.0
Clapp & Jones.	21	567	1893	6,475	6.998	4.375	7.00	524	29.5	86.0
Clapp & Jones.	7	531	1890	6,940	8.50	5.00	7.00	691	32.0	112.0
Clapp & Jones.	15	2162	1893	7,970	9.005	5.49	8.00	957	35.5	140.5
Silsby	42	2159	1893	...	...	....	.....	.....	32.5	174.
Silsby	23	976	1890	7,625	.....	.....	.....	....	36.0	225.
Silsby	33	813	1888	.....	....	.....	....	.....	36.0	229.

The method of making the tests was as follows :

The engines drew their water supply from a Post hydrant, located at the end of an 8-inch main in the Water Department yard. This 8-inch main, 240 feet in length, was connected with the 12-inch main in Albany street.

The water-pressure at the hydrant was about 42 lbs. when the engines were not drawing.

The hydrant has an inside diameter of $6\frac{3}{4}$-inches, with three outlets for hose connection, two of $4\frac{1}{2}$-inch diameter, and one of $2\frac{1}{2}$-inch diameter, each outlet having an independent valve.

The steamers were connected with one of the $4\frac{1}{2}$-inch outlets by means of the ordinary 4-inch suction hose from the steamer.

Frequent pressures were taken by means of a gauge connected with a piezometer which was coupled to the hydrant nozzle and to which the suction-hose was connected.

All water used in the boilers was carefully weighed and the quantity checked by meter measurement. All coal used by each engine was weighed, but no attempt was made to obtain the amount of ashes or unburnt coal. All gauges used were carefully tested by means of a Crosby gauge tester and the readings corrected when necessary. The hose used was new Callahan jacket hose having nominal diameters of $2\frac{1}{2}$ and 3 inches, but the actual inside diameters were 2.65 and 3.30 inches.

The length of hose used during the tests was usually 500 feet for each line except when using the large Siamese nozzle, in which case lines 200 feet in length were used. During some of the first tests made, the lengths of the lines were 400 feet.

At the Lincoln-street fire the average length of the 71 lines of hose used was 530 feet, and at the Tremont Temple fire it was 500 feet.

Standard smooth nozzles were used in all tests, with a single exception, when a test was made to show the comparative efficiency of smooth and ring nozzles. The quantity of water discharged by the steamers was calculated from observations of the pressure, made by means of gauges attached to piezometers at the base of the play pipes, using the well-established formula deduced from the experiments of Mr. J. R. Freeman. The experiments of Mr. Freeman, which were made with great care and covering a great variety of patterns of nozzles, as well as a large range of pressures, proved that by carefully conducted observations the discharge from any of the standard nozzles can be determined within one-half of one per cent.

Careful measurements were made of the diameters of the nozzles, and in nozzles of the same nominal diameter there was found a variation of .014 of an inch.

The engine tests were conducted in the following manner :

Steam was first raised in the boiler to a pressure at which the engine could do practical service ; the fire was then drawn and a new fire started with weighed fuel. As soon as the steam pressure began to rise the engine was started, and run with, as nearly as possible, a uniform steam and water pressure.

Changes in the conditions were made at periods of from fifteen to thirty minutes, either by changing the sizes of the nozzles, the steam pressure, or the length or size of the lines of hose, the object of the tests being to ascertain the quantity of water which each engine was capable of throwing upon a fire in continuous service, and not the quantity which might possibly be discharged through a short line of hose or an open butt for one or two minutes.

Observations of the steam and water pressures at the engine were made every minute, and of the water pressure at the nozzles every thirty seconds. In the tables giving the results of the trials, averages of these observations are given

All coal used under the boilers and all water fed to the boilers was carefully weighed. Pressures were taken on the supply-main at the base of the hydrant, on the $2\frac{1}{2}$-inch outlet of the hydrant and at a piezometer attached to the $4\frac{1}{2}$-inch outlet with which the suction-pipe from the engine was connected.

These pressures were taken to show the loss of pressure by friction in the hydrant and the available pressure in the steamer suction. In the tests of Engines Nos. 27, D, 36 and 15, pressures were also taken at the suction chamber of the engine.

Calorimetric measurements were made of the amount of moisture in the steam furnished by the different types of boilers.

Indicator cards were taken from the steam cylinders of Engine D and Engine No. 15.

The number of revolutions made by the engines were electrically recorded by an instrument made by an employee of the Fire Department.

Each revolution of the engine closed a circuit and was recorded on a paper tape. By the use of a stop watch the number of revolutions per minute was easily and accurately determined.

In order to obtain information in regard to the effect of a hydrant supply, as compared with drafting, tests were made of Engines No. 43 and No. 36 taking water from a large box which was floated in the dock alongside of the Water Department wharf. The box was supplied with fresh water from a hydrant in the yard.

Results and Conclusions.

The following tables show the results of the trials in a convenient form :

Table No. 2 gives the length of the trials, average steam and water pressure at the engine, the quantities pumped, coal used, water evaporated, etc.

Table No. 3 gives the results obtained by each engine under different conditions of steam pressure, length of hose, diameter of nozzles, etc., with the time during which the engine was operated under those conditions.

It will be seen from an inspection of column 9 of Table No. 2 and column 4 of Table No. 3, that engines Nos. 36, D, 21, 43, and 15 equalled or exceeded their calculated capacity at 300 revolutions per minute for runs of from 35 to 89 minutes, and that the average amount pumped per minute by Engines 21, 36, and 43, for the whole time while the pumps were working, was in excess of their calculated capacity.

The tests also show that the smallest-sized engines in use in the department are capable of delivering through 500-foot lines of hose two good fire streams, and that the large-size Clapp & Jones engines will deliver from 900 to 975 gallons per minute, equal to three good 1¼-inch streams.

It must be remembered that in all cases the engines tested drew their water supply from a hydrant under a pressure of from 30 to 40 lbs., and that the steamers of the same class would not be able to deliver as powerful streams if obliged to draft their supply.

This statement is verified by the results of tests of Engines 36 and 43.

I wish to call your attention to the desirability of using two lines of hose with siamese connections in cases where the steamers are so located that lines more than 500 feet in length are required to reach a fire, or where very powerful streams are needed.

In the case of Engines 36 or 21, the smallest size tested, with a single line of 2½-inch hose 800 feet long, a water pressure of 150 lbs. at the engine would give, with a 1¼-inch nozzle, a pressure of but 30 lbs. at the nozzle, while with the same engine pressure, using two lines each 800 feet long siamesed into a 50-foot line with a 1⅜-inch nozzle, a nozzle pressure of 55 lbs. would be obtained. In the first case, the discharge would be about 250 gallons per minute, and the stream would not be effective above the third story, while in the latter case a stream discharging 425 gallons per minute would be available 80 feet above the ground.

The tests showed very conclusively that the capacity of the engines in most instances depended upon the capacity of the boiler to supply steam and it was only by very careful firing of the boilers that the best results could be obtained.

The evaporation per pound of coal from and at 212 degrees varied from 2.26 lbs. in the case of Engine No. 36 to 5.87 lbs. for Engine No. 43.

The slip, or loss through the valves and pistons of the pumps, varied from 3 to 8 per cent. of the calculated displacement of the pump plungers.

Engines Nos. 36 and 43 showed a loss of about 5 per cent. when taking their supply from the hydrant, and 8 per cent. when drafting.

The question is sometimes raised as to whether the supply of water at the hydrants is sufficient for the supply of the steamers.

It seems to me that more positive information could be obtained on this point, if a combined pressure and vacuum gauge were attached to the suction chamber of all engines. This plan has been adopted in Detroit with good results.

Capacity of Hydrants.

During all the tests, except when drafting, the engines were attached to a Post hydrant which was located at the end of an 8-inch pipe, 240 feet long, connected with a 12-inch main in Albany street.

The hydrant, as before described, had an inside diameter of 6¾ inches, a 6-inch rubber valve, and three outlets for hose connections, each controlled by an independent valve. Two of these outlets were 4½ inches, the other 2½ inches in diameter.

TABLE No. 2.

1.	2.	3.	4.			5.			6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
Date of Test.	Style of Engine.	Department No.	Duration of Test.			Length of Time Pumps Running			Average Steam Pressure.	Average Water Pressure at Steamer.	Total Quantity Pumped.	Average Quantity Pumped per Minute.	Total Coal Used.	Total Water Evaporated.	Water Evapor'd per lb. Coal.	Water Evapo'ted per lb. Coal from and at 212°	Duty in Foot-lbs. per 100 lbs. Coal.	Coal used per sq. ft. Grate per Hour.
			Hours.	Minutes.	Seconds.	Hours.	Minutes.	Seconds.	Lbs.	Lbs.	Gallons.	Gallons.	Lbs.	Lbs.	Lbs.	Lbs.		Lbs.
Oct. 19	Clapp & Jones	7	2	45	40	2	31	10	68.8	119.2	90,029	596	1,429	5,930	4.15	4.94	10,201,600	117.3
" 20	" "	43	2	55	30	2	42	40	72.1	119.6	88,714	545	1,049	5,168	4.93	5.87	14,026,000	103.3
" 24	Amoskeag ..	27	2	54	15	2	30	15	71.5	136.4	68,891	459	1,716	4,150	2.42	2.88	8,112,900	138.4
" 25	"	14	3	18	30	2	59	55	75.7	113.8	86,698	482	2,071	6,188	2.99	3.57	5,882,000	141.6
" 26	Silsby	42	2	56	30	2	51	10	76.5	111.5	82,423	482	1,601	6,043	3.77	4.49	7,187,400	142 5
" 30	"	23	1	52	45	1	48	55	59.0	102.1	45,646	419	835	2,962	3.55	4.22	6,482,100	91.1
" 31	"	33	2	20	..	2	..	30	74.7	128.1	68,869	572	1,756	5,555	3.16	3.76	7,265,000	148.4
Nov. 1	"	23	..	52	30	..	49	..	87.8	126.8	27,630	564	644	2,209	3.43	4.10	7,993,400	151.4
" 3	Amoskeag ...	27	3	5	..	2	52	15	82.4	138.1	100,665	585	2,734	6,219	2.27	2.72	7,338,900	207.6
" 6	"	D	2	59	30	2	37	45	78.4	123 3	84,402	535	2,361	5,273	2.23	2.66	5,900,000	191.0
" 8	" ..	36	3	22	15	2	54	45	90.2	143.2	95,963	549	2,560	4,840	1.89	2.26	7,619,800	191.0
" 9	Clapp & Jones	21	3	23	50	3	03	55	92.7	143.0	98,675	536	2,103	6,068	2.88	3.45	9,678,400	181.6
" 13	" "	15	3	08	10	2	23	..	101.3	112.8	130,121	910	2,869	8,398	2.93	3.51	7,758,300	172.1
" 14	Amoskeag ..	36	2	07	30	2	01	10	92.3	124.0	60,307	499	1,563	.....	.....	.....	9,632,700	184.8
" 16	Clapp & Jones	43	1	31	20	1	10	5	102.7	121.2	31,413	449	864	.....	.... ..	.....	8,736,300	163.7

TABLE No. 3.

1.	2.	3.		4.	5.	6.	7.	8.	9.	10.	11.
Engine No.	Cal. Capacity at 300 Revolutions.	Time.		Total Discharge per Minute	No. of Lines.	Length of Lines.	Diameter of Nozzle.	Water Pressure at Nozzle.	Discharge per Minute each Nozzle.	Average Steam Pressure in Boiler.	Average Water Pressure at Engine.
	Gallons.	Min.	Sec.	Gallons.		Feet.	Inches.	Pounds.	Gallons.	Pounds.	Pounds.
36	498	74	50	562	2	500 500	$1\frac{1}{8}$ $1\frac{1}{8}$	55.75 55.75	281 281	70.0	130.9
36	498	42	35	579	2	500 500	$1\frac{1}{8}$ $1\frac{1}{4}$	54.75 41.25	278 301	106.3	128.0
36	498	17	30	596	2	500 500	$1\frac{1}{4}$ $1\frac{1}{8}$	44.0 58.0	310 286	123.7	136.4
36	498	16	..	460	1	*500	$1\frac{1}{4}$	96.5	.....	100.7	204.3
36	498	9	15	564	2	500 500	Siamesed $1\frac{1}{8}$	65.2	....	103.3	147.1
36	498	8	20	425	1	500	$1\frac{1}{4}$	82.5	.....	111.4	244.5
36	498	62	20	512	2	500 500	$1\frac{1}{8}$ $1\frac{1}{8}$	46.2 46.2	256 256	90.0	114.4
†36	498	28	..	532	2	500 500	$1\frac{1}{8}$ $1\frac{1}{4}$	46.0 35.0	255 277	78.5	110.8
36	498	15	5	379	1	500	$1\frac{1}{4}$	65.5	.. ....	112.0	199.6
36	498	9	..	575	2	500 500	Siamesed $1\frac{1}{2}$	67.8	....	123.6	149.8
D	562	89	20	561	2	500 500	$1\frac{1}{8}$ $1\frac{1}{4}$	51.2 39.0	269 292	77.5	118.3
D	562	18	30	562	2	*500 500	$1\frac{1}{4}$ $1\frac{1}{8}$	44.0 44.5	311 251	72.6	110.9
D	562	15	40	478	1	*500	$1\frac{1}{2}$	47.0	... . .	87.6	163.2
D	562	8	50	533	2	500 500	Siamesed $1\frac{1}{2}$	58.2	....	80.0	127.4
D	562	8	5	674	2	200 200	Siamesed $1\frac{1}{2}$	51.7	. .. .	75.3	97.2
D	562	7	10	353	1	500	$1\frac{1}{4}$	56.8	.....	88.3	173.1
14	594	52	..	528	2	400 400	$1\frac{1}{4}$ $1\frac{1}{8}$	35.2 44.2	278 250	78.3	104.8
14	594	37	10	512	2	400 400	$1\frac{1}{8}$ $1\frac{1}{8}$	46.5 46.5	256 256	79.2	108.5
14	594	24	50	325	1	600	$1\frac{1}{8}$	48.2	.....	82.9	178.4
14	594	13	30	495	2	500 500	Siamesed $1\frac{1}{2}$	50.2	....	78.2	122.2
14	594	12	..	466	2	400 400	$1\frac{1}{8}$ $1\frac{1}{8}$	38.5 38.5	233 233	74.0	92.6

*Three-inch hose.
†Supply drafted from tank.

TABLE No. 3. – *Continued.*

1.	2.	3.		4.	5.	6.	7.	8.	9.	10.	11.
Engine No.	Cal. Capacity at 300 Revolutions.	Time.		Total Discharge per Minute.	No. of Lines.	Length of Lines.	Diameter of Nozzle.	Water Pressure at Nozzle.	Discharge per Minute each Nozzle.	Average Steam Pressure in Boiler.	Average Water Pressure at Engine.
	Gallons.	Min	Sec	Gallons.		Feet.	Inches.	Pounds.	Gallons.	Pounds.	Pounds.
14	594	9	30	427	2	400	$1\frac{1}{8}$	32.3	213.5	67.8	67.4
						400	$1\frac{1}{8}$	32.3	213.5		
14	594	7	..	580	2	200	Siamesed	38.4	.....	63.5	80.7
						200	$1\frac{3}{4}$		.....		
14	594	6	15	460	2	450	Siamesed		.....	62.6	107.3
						550	$1\frac{1}{2}$	43.5	.....		
14	594	4	30	506	2	400	$1\frac{1}{8}$	45.3	253	52.8	109.7
						400	$1\frac{1}{8}$	45.3	253		
14	594	3	15	477	2	500	Siamesed		.....	69.0	116.4
						500	$1\frac{1}{4}$	46.8	.....		
14	594	3	..	575	2	200	Siamesed		.....	45.0	80.0
						200	$1\frac{3}{4}$	37.8	.....		
						First Trial.					
27	619	55	45	356	1	500	$1\frac{1}{2}$	57.7	.....	79.8	116.7
27	619	41	30	520	2	500	$1\frac{1}{4}$	34.0	273	62.7	110.3
						500	$1\frac{1}{8}$	43.2	247		
27	619	37	30	496	2	500	$1\frac{1}{2}$	43.5	248	70.4	110.8
						500	$1\frac{1}{8}$	43.5	248		
27	619	15	20	687	2	200	Siamesed		.....	84.5	119.5
						200	$1\frac{3}{4}$	53.8	.....		
27	619	6	..	607	2	200	Siamesed		.....	86.7	90.8
						200	$1\frac{3}{4}$	42.1	.....		
						Second Trial.					
27	619	41	10	594	2	500	$1\frac{1}{2}$	57.5	285	78.7	142.7
						500	$1\frac{1}{4}$	43.5	309		
27	619	18	..	640	2	*500	$1\frac{1}{4}$	55.0	347	82.0	128.1
						500	$1\frac{1}{4}$	39.3	293		
27	619	17	35	596	2	500	$1\frac{1}{4}$	40.7	298	104.7	134.0
						500	$1\frac{1}{4}$	40.7	298		
27	619	16	30	587	2	500	$1\frac{1}{2}$	61.0	293.5	97.5	148.4
						500	$1\frac{1}{4}$	61.0	293.5		
27	619	16	20	566	2	500	Siamesed	65.7	.....	75.5	154.7
						500	$1\frac{1}{2}$		....		
27	619	11	50	609	2	500	$1\frac{1}{2}$	60.5	292	93.3	147.8
						500	$1\frac{1}{4}$	46.0	317		
27	619	11	20	604	2	500	$1\frac{1}{4}$	59.5	290	72.5	147.1
						500	$1\frac{1}{4}$	45.0	314		
27	616	7	20	576	2	500	$1\frac{1}{2}$	38.0	288	79 4	131.3
						500	$1\frac{1}{4}$	38.0	288		

*Three-inch hose.

TABLE NO. 3.—*Continued.*

1.	2.	3.		4.	5.	6.	7.	8.	9.	10.	11.
Engine No.	Cal. Capacity at 300 Revolutions.	Time.		Total Discharge per Minute.	No. of Lines.	Length of Lines.	Diameter of Nozzle	Water Pressure at Nozzle.	Discharge per Minute. each Nozzle.	Average Steam Pressure in Boiler.	Average Water Pressure at Engine.
	Gallons.	Min	Sec	Gallons.	No.	Feet.	Inches.	Pounds.	Gallons.	Pounds.	Pounds.
43	525	57	30	577	2	400	1¼	42.0	303	70.8	116.7
						400	1⅛	53.0	274		
43	525	48	..	556	2	400	1⅛	54.7	278	73.2	115.7
						400	1⅛	54.7	278		
43	525	26	50	526	2	500	1⅛	50.7	268	75.2	122.5
						500	1⅛	50 7	268		
43	525	20	10	535	2	500	1¼ Ring	56.0	263	72.9	133.5
						500	1⅛	52.2	272		
43	525	16	..	517	2	500	1⅛	47.25	258.5	109.3	116.5
						500	1⅛	47.25	258.5		
43	525	13	50	547	2	500	1⅛	48.2	261	105.9	112.4
						500	1¼	37.5	286		
§43	525	12	40	435	2	500	1⅛	33.5	217.5	87.5	87.1†
						500	1⅛	33.5	217.5		
43	525	11	20	467	2	500	1⅛	38.5	233.5	98.2	93.1†
						500	1⅛	38.5	233.5		
43	525	3	45	304	1	1,000	1¼	42.3	.....	113.3	205.7
21	524	48	35	575	2	500	1⅛	53.5	275	89.4	124.7
						500	1¼	41.0	300		
21	524	41	..	582	2	500	1⅛	60.0	291	90.7	140.2
						500	1⅛	60.0	291		
21	524	24	10	607	2	500	1¼	45.3	315	112.0	138.1
						500	1⅛	60.3	292		
21	524	11	25	576	2	500	Siamesed	68.0	.....	102.3	152.8
						500	1⅛		.....		
21	524	10	45	573	2	500	1⅛	53.5	275	82.3	127.0
						500	1¼	40.5	298		
21	524	8	15	472	1	‡500	1½	101.5	.....	114.9	219.5
21	524	8	10	407	1	500	1¼	75.5	....	107.9	221.4
21	524	7	30	479	1	*500	1¼	104.0	.....	118.8	217.5
21	524	5	10	277	1	500	1¼	35.1	.....	42.2	109.1
21	524	3	40	294	1	500	1¼	39.5	....	44.0	117.4

*Three-inch hose.
†Air leaking into the suction through the relief valve.
‡Three-inch hose fitted with 2½-inch couplings.
§Supply drafted from tank.

TABLE No. 3.—*Continued.*

1.	2.	3.		4.	5.	6.	7.	8.	9.	10.	11.
Engine No.	Cal. Capacity at 300 Revolutions.	Time.		Total Discharge per Minute.	No. of Lines.	Length of Lines.	Diameter of Nozzle.	Water Pressure at Nozzle.	Discharge per Minute each Nozzle.	Average Steam Pressure in Boiler.	Average Water Pressure at Engine.
	Gallons.	Min	Sec	Gallons.		Feet.	Inches.	Pounds.	Gallons.	Pounds.	Pounds.
7	691	45	..	640	2	400 400	1¼ 1⅛	52.0 64.7	338 302	85.1	147.0
7	691	33	40	504	2	400 400	1⅛ 1⅛	45.0 45.0	252 252	51.0	98.4
7	691	24	..	581	2	400 400	1¼ 1⅛	42.7 53.5	306 275	65.2	119.6
7	691	19	..	563	2	400 400	1⅛ 1⅛	56.0 56.0	281.5 281.5	70 0	124.2
7	691	12	..	697	2	200 200	Siamesed 2	31.5	....	61.4	86.7
7	691	9	..	725	2	200 200	Siamesed 1¾	.. 60.0	....	89.8	123.4
15	957	64	10	900	3	500 *500 500	1⅛ 1¼ 1⅛	53.5 55.7 53.5	275 350 275	107.4	130.3
15	957	35	35	978	4	500 500 *500 500	1⅛ 1⅛ 1⅛ 1⅛	39.0 39.2 52.0 39.2	235 236 271 236	95.3	96.3
15	957	12	30	989	4	200 200 200 *450	Siamesed 2	63.0	....	95.3	101.4
15	957	11	50	1,022	4	500 500 *500	Siamesed 1¾ 1⅛	64.0 51.5	752 270	98.2	96.6
15	957	4	50	749	2	*500 500	1¼ 1⅛	82.8 74.0	426 323	115.1	173.9
42	.....	50	30	515	2	400 400	1⅛ 1⅛	46.5 46 5	257.5 257.5	78.9	101.6
42	.....	37	50	550	2	400 400	1⅛ 1¼	48.5 38.0	262 288	74.5	102.2
42	.....	14	20	441	1	*500	1½	40.0	.....	86.6	143.4
42	.....	12	..	502	2	500 *500	1⅛ 1⅛	38.5 50.7	234 268	71.2	96.8
42	.....	11	..	529	2	500 *500	1⅛ 1¼	36.7 41.2	228 301	66.1	90.4
42	.....	10	..	327	1	500	1⅛	48.8	.. .	83.8	151.1
42	.....	9	20	395	1	*500	1¼	71.0	.....	85.4	158.1
42	.....	7	40	387	1	500	1¼	68.2	....	86.0	151.6
41	.....	4	20	527	2	400 *500	1⅛ 1¼	41.8 37.0	243 284	66.0	88.7

*Three-inch hose.

TABLE No. 3.—*Concluded.*

1.	2.	3.		4.	5.	6.	7.	8.	9.	10.	11.
Engine No.	Cal. Capacity at 300 Revolutions.	Time.		Total Discharge per Minute.	No. of Lines.	Length of Lines.	Diameter of Nozzle.	Water Pressure at Nozzle.	Discharge per Minute each Nozzle.	Average Steam Pressure in Boiler.	Average Water Pressure at Engine.
	Gallons.	Min	Sec	Gallons.		Feet.	Inches.	Pounds.	Gallons.	Pounds.	Pounds.
23	.....	37	..	460	2	500	$1\frac{1}{4}$	27.5	245	55.2	86.4
						500	$1\frac{1}{8}$	32.7	215		
23	.....	27	30	484	2	500	$1\frac{1}{8}$	41.5	242	72 8	104.0
						500	$1\frac{1}{8}$	41.5	242		
23	.....	14	30	295	1	500	$1\frac{1}{4}$	39.7	...	52.9	124.1
23	.....	12	25	335	1	500	$1\frac{1}{4}$	51.2	....	65.4	157.4
23	.....	10	..	470	2	500	$1\frac{1}{4}$	28.7	251	44.6	82.3
						500	$1\frac{1}{8}$	34.0	219		
					SECOND TRIAL.						
23	.....	43	30	590	2	500	$1\frac{1}{4}$	42.5	305	91.4	136.6
						500	$1\frac{1}{8}$	57.5	285		
33	.....	41	30	611	2	500	$1\frac{1}{4}$	42.5	305.5	70.7	127.6
						500	$1\frac{1}{4}$	42.5	305.5		
33	.....	21	..	612	2	500	$1\frac{1}{8}$	61.2	294	79.7	141.1
						500	$1\frac{1}{4}$	46.2	318		
33	.....	19	30	662	2	500	$1\frac{1}{4}$	43.0	307	82.6	124.5
						*500	$1\frac{1}{4}$	57.5	355		
33	.....	17	20	594	2	500	$1\frac{1}{4}$	40.2	297	78.9	120.2
						500	$1\frac{1}{4}$	40.2	297		
33	.....	5	40	403	1	500	$1\frac{1}{4}$	74.0	.....	86.7	207.8
33	.....	4	40	582	2	500	$1\frac{1}{8}$	60.0	291	88.4	139.6
						500	$1\frac{1}{8}$	60.0	291		

*Three-inch hose.

Pressures were taken on the 8-inch pipe at the base of the hydrant and on a piezometer attached to the steamer suction, in order to determine the loss of pressure in passing through the hydrant.

These experiments show that the friction loss in the hydrant when the entire discharge was from one 4½-inch outlet, was 4 lbs. for a discharge of 500 gallons per minute and 16 lbs. for a discharge of 1,000 gallons, also that a large proportion of the total loss is in the outlet valve.

During a trial of the water-tower, three engines were connected with this Post hydrant, and the lowest pressure taken at the piezometer coupling was 20 lbs., showing that hydrants of this pattern will furnish an ample supply for three steamers. Owing to the lateness of the season, the experiments on the capacity of hydrants were not completed.

Friction in Hose.

The experiments were not conducted with special reference to obtaining information on this point, but in general they confirm the more careful experiments made by Mr. John R. Freeman and reported in a paper presented by him to this Association, (Vol. IV., p. 95.)

Experiments were, however, made to show the comparative value of 2½-inch and 3-inch hose and the effect of using 2½ inch couplings on the 3-inch hose.

Bushings 2½-inch in diameter were placed at each coupling in the line of 3-inch hose so as to give the some effect as the use of 2½-inch couplings.

The following table shows the results of the different experiments. The lines of hose were in all cases 500 feet in length.

Number of experiment.	Diameter of discharge nozzles.	Water pressure in lbs. At steamer.	At nozzle. 3-in. hose.	At nozzle. 2½-in. hose.	Discharge in gallons. 3-in. hose.	Discharge in gallons. 2½-in. hose.
1	1¼ in.	128.1	55.0	39.2	347	293
2	1⅛ in.	124 5	57.5	43.0	355	307
3	1⅛ in.	96.8	50.7	38.5	268	234
4	1¼ in. / 1⅛ in.	110.9	44.0	44.5	311	251
5	1¼ in / 1⅛ in.	90.4	41.2	36.7	301	228
6	1¼ in.	217.5	105.0	....	479	3-in. hose. 3-in. couplings.
7	1¼ in.	221.4	....	75.5	407	
8	1¼ in.	219.5	101.5	...	472	3-in. hose. 2½-in. couplings.
9	1¼ in.	204.0	96.5	....	460	
10	1¼ in.	158.6	71.0	....	395	
11	1¼ in.	151.6	68.2		387	
12	1¼ in.	224 0	....	74.7	....	405
13	1¼ in.	157.4	....	51.2	...	335
14	1¼ in.	151.1	....	48.7	....	327
15	1¼ in.	124.1	....	39.7	..	295

In the first three experiments given in the above table, two lines of hose each 500 feet in length were attached to a steamer, and nozzles of the same diameter attached to each line.

With the same pressure at the steamer, the pressures at the nozzles on the 3-inch lines of hose were from 12 to 15 lbs. greater than on the 2½-inch lines. In the fourth and fifth experiments, 1¼-inch nozzles were used on the 3-inch hose and 1⅛-inch nozzles on the 2½-inch. It will be noticed that the effective pressure at the 1¼-inch nozzle on the 3-inch hose was as large as at the 1⅛-inch nozzle on the 2½-inch hose, while the discharge from the nozzles on the 3-inch hose was between 20 and 25 per cent. more.

A comparison of experiments 6 and 8 shows the effect of using 2½-inch couplings on 3-inch hose, and it will be noticed that with the same pressure at the engine, the nozzle pressure is about 5 lbs. less when using the 2½-inch couplings, or for a 500-foot line of hose about ½ lb. loss at each 2½-inch coupling when discharging 475 gallons per minute.

The loss of pressure per 100 feet in the different sizes of hose is approximately as follows:

	250 gallons per minute.	300 gallons per minute.
2½-in. hose	13 lbs.	18 lbs.
3-in. hose, 2½-in. couplings .	8 lbs.	10.7 lbs.
3-in. hose, 3-in. couplings .	8 lbs.	10.5 lbs.

The advantage of using 3-inch hose is illustrated by the following example: With a steamer using a line of hose 600 feet in length, with a 1¼-inch smooth nozzle discharging 300 gallons per minute, a quantity none too large for the needs of the present fire-service, a water-pressure of 150 lbs. at the steamer would be required if 2½-inch hose were used, while with 3-inch hose the same results would be attained with a pressure of 105 lbs. at the steamer.

The advantage of the use of 2½-inch couplings would be that no time would be lost in attaching reducing couplings or in finding hose of the needed size, while the loss of pressure due to the 2½-inch couplings would be insignificant in ordinary use.

Without doubt the 3-inch hose is not so easily handled on ladders or in buildings, but great benefit could be derived by using from 300 to 500 feet of 3-inch hose from the steamer, with one or two lengths of 2½-inch hose attached for the hoseman's use.

A FEW EXAMPLES OF HIGH GRADE PUMPING ENGINES,

BY

E. D. Leavitt, Esq., Mechanical Engineer, Cambridgeport, Mass.

[Read June 15th, 1894, and illustrated by stereopticon.]

You will observe that the subject of my remarks this evening has been changed from the program announcement of the "Latest Improvements in Pumping Machinery" to "A Few Examples of High-Grade Pumping Engines."

The general subject of pumping engines was so thoroughly covered by Mr. Dean's paper, read at the Worcester meeting last year, that it did not seem to me wise to attempt to re-gild fine gold, nor to tire your patience with repetition.

You are well aware that with the immense development of town water supply that followed the late civil war, pumping machinery became an established article of manufacture, the business being organized on the most extensive scale, and subject to the keenest competition. As a matter of course each manufacturer furnishes the best as well as the cheapest engine, and the skill and persistency with which accomplished salesmen are wont to urge the merits of their respective wares are familiar to you all.

The type of machinery about to be considered is not included in the foregoing category, but is special, each machine being designed and constructed for its particular service. Because this method involves a high first cost, it is not popular, and has been resorted to in comparatively few instances. Only those who are firm believers in the axiom that "the best is the cheapest" adopt it.

In the older and wealthier communities, however, there is a growing conviction that low first cost is not the paramount consideration, while low cost of maintenance is, because cost of maintenance is something that always goes on, and is ever with us, to be provided for in our annual tax levies. That such a conviction obtains anywhere, explains why such machinery as we are about to consider has been constructed.

The first three engines that will be described are of a peculiar type which was originally designed for and adopted by the Calumet & Hecla Mining Company, in 1874. Of this type this company has, at the present time, 16 examples, aggregating 25,000 horse power, of which four are pumping engines with an aggregate capacity of 90 million gallons per day.

The first pumping engine, the "Erie," (Plate I.) has been running 20 years, 144 hours per week, and is still as good as new. The considerations which led to the adoption of this type of engine were these: First, an engine which would be able to work continuously 144 hours a week with the least wear and tear. This involves the necessity of vertical cylinders, or cylinders that were nearly so,

and vertical pumps, because the water which was to be pumped carries a large amount of silt, being the discharge from the stamp mills of the company situated at Lake Linden. At that time the company were crushing about 800 tons of rock per day, and the waste from the mills ran into the lake which furnished the supply for these pumps.

It will be observed that it is a compound engine, with the high pressure cylinder placed on an incline, and the low pressure cylinder vertical, the high pressure being connected to one end of the beam and the low pressure to the opposite end of the same. The prolongation of the low pressure piston rod is connected to one pump placed directly under the low pressure cylinder, and there is connection by means of a link from the beam to the pump under the high pressure cylinder. A horn on the beam serves for connection to the crank by means of the connecting rod in the usual manner. The engine is provided with a fly-wheel. It is also provided with a governor which is capable of a great range of speeds, and the action is entirely automatic. The cylinder valves are of the gridiron type, giving a short motion, with very small clearances. The cylinders are both thoroughly steam-jacketted; and everything that is necessary to make an engine as efficient as possible in economy and durability was, at the time of its construction, supposed to be adopted.

It will be observed that a very large air-vessel was provided. The cylinders are 11½ and 24 inches in diameter, by 4½ feet stroke. The pumps are of the ordinary bucket and plunger type, except that they have a supplementary discharge which is placed in the bottom of the air-vessel, as shown. All the water was supposed to go through the bucket on its downward stroke, except such portion as would go more easily through the supplementary discharge valves.

The original capacity of the engine was 4,000 gallons per minute, which would be about 5,800,000 gallons per day. It will be observed that the capacity placed on the illustration is 11,000,000 gallons per day. The way this came about was as follows: The superintendent of the Calumet & Hecla Stamp Mills made a mistake in the amount of water required when the engine was ordered, and its capacity was based on a speed of 19 revolutions per minute. It had hardly started before this speed was found to be inadequate, the quantity of water being very much in excess of 4,000 gallons per minute; so that very soon the engine was running at a speed of 30 revolutions, which, with double-beat valves 13½ inches in diameter and about 1¼-inch lift, made a good deal of racket, but that was all. The performance was satisfactory, and the engine continued to run at increased speeds until finally, it reached a speed of 35 or 36 revolutions per minute, with the same double-beat valves, before a new engine to supplement it could be provided.

After the engine "Erie" was installed, very considerable changes were made in the plant, so that it became necessary to increase the pumping capacity; and a second engine called the "Ontario" was constructed and started in 1876. This engine is shown on Plate II.

It will be observed that on the steam end it follows almost exactly the lines of the "Erie," but a radical departure was made in the pumps. Instead of the

bucket and plunger pumps, what is now known as the differential plunger pump was adopted; and instead of large double-beat valves 13½ inches diameter, a reduction was made to the diameter of 5½ inches, with about ½ inch lift.

The engine "Ontario" was designed to pump 10,000 gallons per minute at a speed of practically 30 revolutions; and it was noiseless and entirely satisfactory in its action. But, like all mining appliances, it was soon found that 10,000 gallons per minute was not enough, and the speed was increased, so that it ran for a long time between 34 and 35 revolutions per minute.

After the "Ontario" had been in continuous service ten years, the foundations which were constructed of sandstone, quarried on the mining company's property, began to show signs of weakness. It appeared that the binding material in the stone became decayed to such an extent that if a piece of it were taken in one's hand, it would crumble into sand. This made it necessary about as quickly as possible to erect new foundations in a different location, and to install another very large horizontal geared pump as a spare. As soon as it was started, the "Ontario" was removed to a new location, and erected on durable foundations. At the same time, the lower plungers (the upper plungers remaining the same) were increased in diameter from 28½ to 33 inches, and a different type of water valve was adopted. The first valves were, as before stated, small double-beats, with about ½-inch lift, but the great amount of residuum in the water coming from the stamp rock made it difficult to keep such valves tight under continuous service, and it was thought better to adopt a valve with a soft seat. Accordingly, rubber valves with a brass backing and closed by springs were adopted, and in that form the pump stands today. With the new valves it has been run continuously at a speed of 37½ revolutions per minute at which speed it delivers 24,000,000 gallons per diem. It has run probably for considerably more than a year at a time at an average speed of 36 revolutions per minute, at which rate it delivers about 22,500,000 gallons per diem and the action is entirely noiseless. In fact, it is so noiseless that at one time the superintendent of the company when standing with his back to the engine examining something else, asked me if it was running.

When the "Ontario" had been running at a capacity of 24,000,000 gallons per day, the demands of the stamp mills increased to such an extent that the horizontal geared pump previously referred to had to be run in addition, the two machines delivering 35,000,000 gallons per day. This condition of affairs made it necessary to start the building of a new pumping engine, and plans for the same were commenced in 1888.

This engine is called the "Michigan" (Plate III.) and it has a capacity of 60,000,000 gallons per diem, at a speed of 30 revolutions per minute, which makes it (supposably) the largest pumping engine, in capacity, in the world. The cylinders are all vertical on this engine. The high pressure and the intermediate cylinders stand side by side, connected to one end of the beam, from which connection is made to one pump. The low pressure is connected to the other end of the beam and to another pump. Both pumps have differential plungers, the diameter for the upper plungers being 34 1-16 inches, and the lower 48 inches. The stroke is 90 inches. The capacity is almost exactly 2,000,000 gallons for each

revolution per minute per diem. The maximum capacity has not yet been reached, the average now being about 44,000,000 gallons per diem.

It will be observed that the bed-plate of the "Michigan" is raised considerably above the floor. The reason for this is that we consider it desirable to keep all our machinery, which is placed in one large house, on the same floor level, and as the stroke was increased to 7½ feet, whereas the "Ontario's" stroke was but 5 feet, it was necessary to raise the "Michigan's" bed-plate a corresponding degree.

A curious thing was discovered about the action of the "Michigan" when it was attempted to run it at its maximum capacity. It has never been run higher than 27 revolutions per minute, at which speed the action of the pumps was entirely noiseless, and the action of the steam end perfectly satisfactory. The pumps stand in a very large wet well which is supplied by an in-take from the lake, 5 feet square. At high speed, the surge of water in the well was so great as to cause fear that the pumps would take air, and it will probably be necessary to put in racks composed of 2-inch planks, 12 inches wide, and placed 2 inches apart, to prevent the surging.

The "Ontario" originally stood in a wet well. When it was changed to the new location, it was impossible to get into the well, and a long suction pipe was adopted, fully 75 feet from the well. This suction pipe which is 36 inches in diameter has a very large vacuum-chamber on it, and its action has been so satisfactory as to convince me that wherever it is practicable, it is the best way to arrange the in-take of a pump. The old idea was always to put pumps in wet wells. You will notice that the English pumping engines have almost entirely been constructed that way, and the original Brooklyn engine, at Ridgewood Station, as well as a great many engines subsequently erected of the vertical type, have been similarly made.

The steam end of the "Michigan" is practically like that of the "Ontario" except that the exhaust steam passes through reheaters filled with small tubes in which live steam circulates. This has proved very efficient, and has increased the economy of the engine. The actual performance of this engine for six months, (and it has been doing better since), was 1,000,000 gallons raised 1 foot high for 3.61 cents, of which the cost for fuel only was 1.48 cents. The coal is carried 1,000 miles, and is of a very inferior quality to that which is used here, being sent from Pittsburg. Its calorific value is estimated at from 70 to 80 per cent. that of Cumberland and Pocahontas, such as is used in this vicinity.

It may interest the association to know that the "Erie" and the "Ontario" saved their entire cost including foundations, buildings, boilers and chimney inside of 17 months.

We now come to an engine which antedates the "Michigan" and is of a type peculiar to itself, viz: the Louisville Water Company's engine No. 3, (Plates IV. and V.) Before the plans for the "Michigan" were started, the trustees of the Louisville Water Company consulted me in regard to a pumping engine for their works, and their chief engineer and superintendent, Mr. Charles Hermany, visited Calumet to see the performance of the "Ontario." The result was that the Louisville Water Company decided to adopt an engine of that type, with

certain modifications to suit their peculiar conditions, and this engine was subsequently contracted for with the I. P. Morris Company of Philadelphia, who have made a magnificent job of it.

One of the conditions that had to be provided for at Louisville was the immense rise and fall of the Ohio River at that point. A freshet the year before the design was made covered the old engine room and boiler house floors to a depth of three or four feet. Mr. Hermany therefore concluded that some day there would be a very much higher freshet than that, and the floor of the new engine house is something like ten feet higher than the old, and the height from the bottom of the pump pit to the under side of the bed-plate is 62 feet, and the total height of the engine is 92 feet.

This engine has a capacity of 16,000,000 gallons per day against a head, as developed on a recent test, of about 193½ feet. It is "made good for stout." The pump chambers are of gun iron 4 inches thick, with a diameter inside of 8 feet. The lower castings each weigh 30 tons, and the total weight of the pumps is something like 400 tons. The high pressure cylinder is 27 inches diameter by 10 feet stroke; the low pressure cylinder is 54 inches diameter by 10 feet stroke. Reheaters are placed between the cylinders, substantially the same as in the design for the Boston Sewage engines, the plans for which were made several years before those of the Louisville engine. The steam-valves and valve gear are like the "Ontario's." The condenser is of the surface type, with a by-pass. Ordinarily, all the water goes through the surface condenser.

This engine was a long while under construction. The people in the South do not ever seem to be in a hurry. The trustees of the Louisville Company had the plans of the engine for three or four years before they let the contract, and after the engine was built, it stood a year in the shop; it also stood a year or two in the engine house. It was finally started a year ago, and has been recently tested by two members of this association. On a six days' test it is reported to have given a duty of very nearly 130,000,000; on the coal actually consumed, 129,653,000; and on the basis of 1,000 pounds of dry steam, a duty of 148,655,000.

It is proper that I should make a remark here about the question of duty. The kind of duty that water boards and water superintendents are interested in is the coal-pile and reservoir duty. What costs money is the coal, and what brings money is the water delivered. And while it is very well from a scientific standpoint to figure on the steam part of the engine as a heat machine, what we are really interested in and want to do is to make an engine which will put the most water into the reservoir with the fewest pounds of coal.

A remarkable thing about the Louisville engine, which is enormously heavy, (the fly-wheel alone being 36 feet in diameter, and weighing 57 tons,) is the extremely low percentage of friction, the same being only 6.6 per cent. of the indicated power, thus giving a mechanical efficiency of 93.4 per cent.

We next come to an engine (Plate VI.) which is now in course of construction, and which resembles the others somewhat in being a rocker type of engine, with the main beam and the shaft centers on the same horizontal plane, and a connection from the horn on the beam to the crank, similar to the engines previously

described. The pumps have differential plungers also, but the steam cylinders are for cheaper construction made of the Corliss type. This engine has also a horizontal air-pump. It differs in hardly any respect from the Louisville engine except that it is smaller. The cylinders are 21 and 42 inches in diameter by 48 inches stroke. The George F. Blake Company are the builders, and the engine will be erected at the Mystic Pumping Station of the Boston Water Works. The reheater is placed at one side. There is a steam separator through which the steam passes before it enters the high pressure cylinder; the exhaust from the high pressure passes through a reheater to the low pressure cylinder.

The engines previously described may be considered as a natural evolution from the original Lynn engine, and its successor, the Lawrence engine, both of which are familiar to the members of this association.

The next engine to be described is one which I think the association, or at least some of its members, have seen, viz: the Boston High Service Engine No. 3. (Plates VII. and VIII.) It will be observed that this engine differs considerably from those already spoken of. It is of the rocker type, but the pumps are placed at one side. The reason of this departure was on account of the necessity of adapting the engine to the house. It was impossible to get an engine of the previously described designs, having suitable length of stroke, into the space allotted. On this engine, the Riedler type of valve gear has been adopted. It is to run very fast, its speed for capacity being 50 revolutions per minute. The valves will be positively closed by a wrist motion similar to that used in the Corliss steam valve gear. A surface condenser has been provided, and it will be observed that the air-vessel capacity is extremely large. This has been found to be absolutely essential with fast running engines. The steam valves and valve gear are similar to those described previously. Another departure is that the engine has three cranks, for the reason that it was at the time the design was entered upon supposed to be the best for smooth working. Since the "Michigan" has run so successfully with a single crank, I have to confess that I have changed my mind in regard to the necessity for more than one crank.

Leaving now the description of the Water Works pumping engines, we come to an engine which was designed for a very peculiar service, and is probably the largest stationary engine in the world. It is the Bethlehem Iron Company's Engine, No. 900, sometimes called "The Kaiser." Its function is to pump water for a forging press, under a pressure of 7,000 pounds to the square inch. It is not a multi-cylinder engine, for the reason that the service is such that it would be impossible to perform it satisfactorily with that type of construction. It is not even a condensing engine, because its duty is done in a very few minutes, the actual time when the pressure of 7,000 pounds to the square inch prevails being not over one revolution, after which the pressure is relieved, and the engine runs free. The cylinders are 50 inches in diameter, with a stroke of 90 inches, and adapted to a working pressure of 160 pounds per square inch. The pumps are steel forgings that weighed in the rough, 17½ tons. They were cut out of the solid for the plungers, and for the valve passages. They are held in what we call head stocks, each of which weigh 38 tons. The delivery pipes

are steel forgings bored out, with the flanges screwed on, and the amount of bolting required is something that has to be seen to be appreciated. All the valves are worked by Riedler gear. The speed of the engine is 60 revolutions per minute, which gives 900 feet speed a minute for the steam pistons and 450 feet per minute for the water end.

The engine is of the same type as the Boston High Service No. 3, the rockers having connections to the cranks at one end, and to the pumps at the other, the stroke of the pumps being one half that of the steam pistons. It will be remarked that the power of each cylinder (5,000 horse-power,) is applied to a pump plunger 7.8 inches in diameter. Perhaps no better idea of the power required to forge heavy armor-plates could be given than in this statement. The forging-press, which is supplied with water by the engine No. 900, has a capacity of exerting a pressure of 14,000 tons on an ingot, and it is common work to forge an 80-ton ingot into an armor-plate inside of two hours. There would probably be no difficulty whatever at this plant in forging all the armor-plate that is needed for the navies of the world, and it could then remain idle half the time. The water valves are necessarily very small, so that the speed of water through them is 60 feet a second.

Let us now consider some details of the pumps, the object being to give you an idea of what is necessary in making high-grade machinery, and where the cost comes in. The cut (Fig. 1) shows a section of the machinery of the Boston Sewerage Pump which has a 48-inch plunger with a stroke of 9 feet. The valves in this particular case were made so as to allow the passage of a good deal of stuff other than water, and as a fact, a piece of plank 2 inches thick, 12 inches wide and 3 feet long was passed through one of these pumps. The valves have about $3\frac{3}{4}$ inches width of opening, and $13\frac{1}{2}$ inches of length. Both the inlet and the delivery valves are of the same type, but the area of the suction valves is 33 per cent. greater than that of the delivery valves. The construction was necessarily very expensive, the idea being that water must flow as easily as possible, and with the least change of direction, as is always desirable with any pump.

The next cut (Fig. 2) shown is that of the bucket and plunger type of pump, which is in use at Lawrence, the plunger, the bucket valve and the suction, with the supplementary delivery valve are all shown. Originally, the Lawrence pump was fitted with brass double-beat valves 16 inches in diameter. When the engine was tested in 1877 by the official board, the mechanical efficiency was found to be low, and it occasioned a good deal of speculation as to the cause. Double-beat valves had been used in the Lynn engine, and the mechanical efficiency was high, while that of the Lawrence engine fell 7 or 8 per cent. below it. It was decided to change the pump valves to see if the efficiency could be increased. Annular valves having rubber faces, were substituted for the double-beats, which valves were heavily loaded to bring them down quickly. The efficiency immediately rose to nearly 92 per cent. of the indicated power. The duty obtained on the first trial was between 96,000,000 and 98,000,000; after the valves were changed, a duty of 111,000,000 was developed, all of which could be accounted for by the increase in mechanical efficiency.

We now come to the differential plunger, (Fig. 3,) such as was in use in the

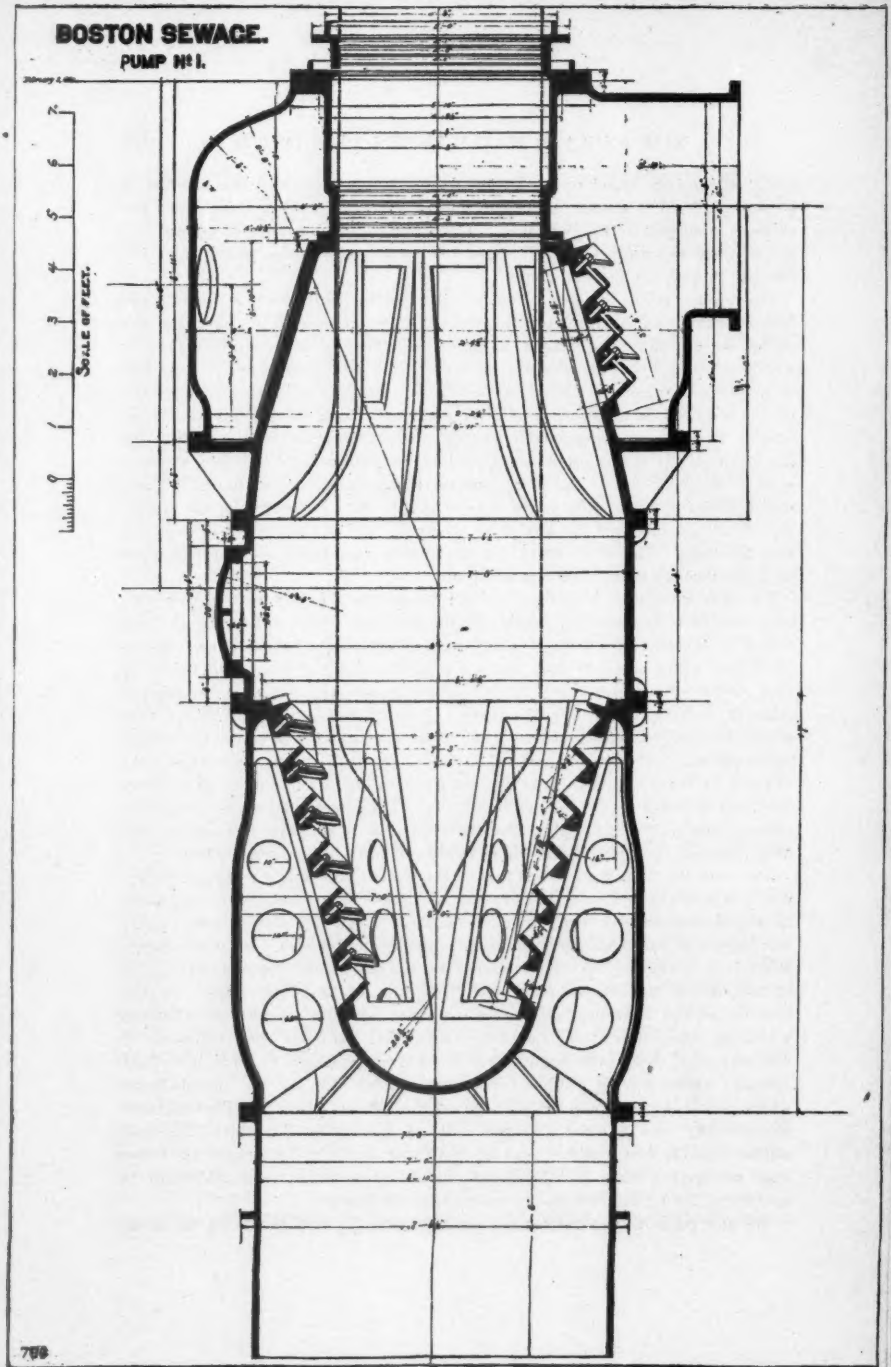


FIG. 1.

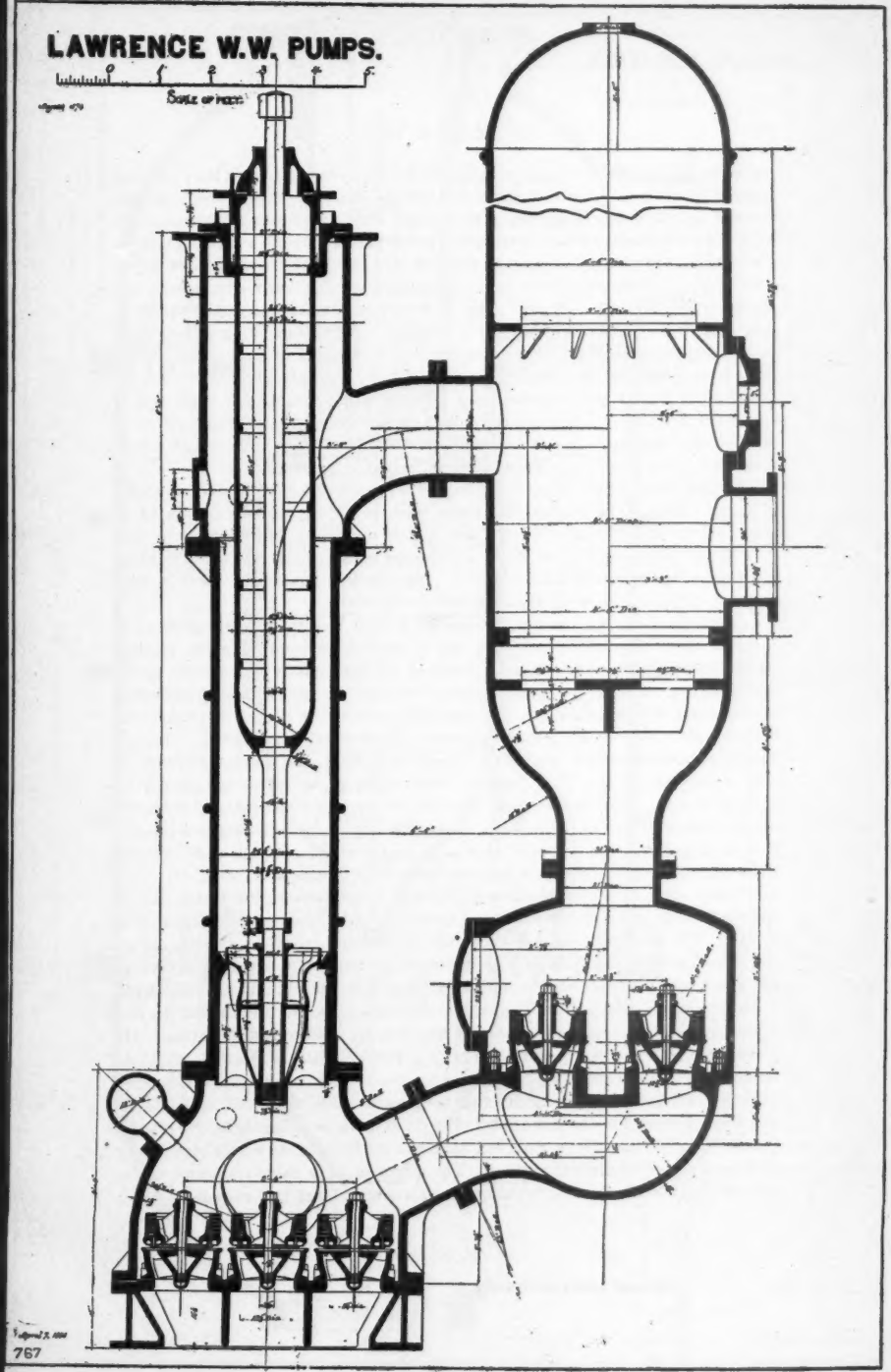


FIG. 2.

pumping engine "Ontario" and which is substantially the same as in the pumping engine "Michigan." You will notice that there is an upper plunger which passes through a stuffing-box in the top of the pump. This upper plunger is connected with a lower plunger of double the area, which passes through a hanging sleeve. The action is precisely the same as the action of the bucket and plunger type.

The full displacement of the lower plunger enters the lower chamber as the plunger ascends. At the same time, half of the water in the upper chamber goes out, by the entrance of the lower plunger. When the plunger descends, an amount of water in the lower chamber which is equal to the volume of the lower plunger passes through the delivery valves, but only one-half of it goes out into the force-main, because of the difference in displacement of the upper and lower plungers. The great advantage of the differential plunger pump is the fact that the water passing through it suffers a minimum change of direction, and it also allows of a practically unlimited valve area.

The next illustration (Fig. 4,) is to show the change that has come about in pump valves. The original Lawrence valve is shown, also the second Lawrence valve, the "Ontario" valve and the valves which will be used in the new Mystic Pumping Engine No. 4. These are substantially like those used in the Louisville Pumping Engine No. 3. The Corliss Pawtucket valve is also shown. The relative sizes are correct.

As regards the Corliss valves, I have had a good deal to do with them, and consider them very efficient. They are in use at Calumet, in mine pumps underground, which work under a pressure of 250 pounds per square inch. The pumps are driven by electric motors, and make 50 double strokes per minute; the action is satisfactory. The contrast between the Corliss valve and the Riedler valve used in the Boston Pumping Engine No. 3 is striking. In the Riedler construction, but one valve is used for suction, and one for delivery at each end of the pump. The rapidity with which these valves are moved is worthy of note. They are to open and close 50 times per minute, and it would be impossible to stay in the building except for this positive closing movement. It is an actual fact that valves of this type have been run as high as 80 revolutions per minute with absolute freedom from noise or shock.

We now come to a consideration of some of the details of the steam end of the machinery, and will first take a cylinder from the Chestnut Hill Engine No. 3, (Fig. 5,)—the cut does not show all the details described—which shows the construction of a jacketed cylinder whose two walls are cast together, the outer wall being cut through at the middle of its length, and provided with a copper expansion joint. The valve seats are separate and bolted to the cylinder faces. These valve seats are adapted for gridiron slide valves. All the work about the valves and valve seats is carefully scraped, and is finished when the cylinders are hot. As there is no machine yet made which is capable of doing this work well enough to suit the requirements, the actual cost of construction is more for the hand-work that is done in scraping, than for all the machine work. It will be observed that the gridiron slide valves give a very large opening with a short motion. The ports in both valve seats and valves are carefully slotted. The backs of the valves are planed and rounded over at

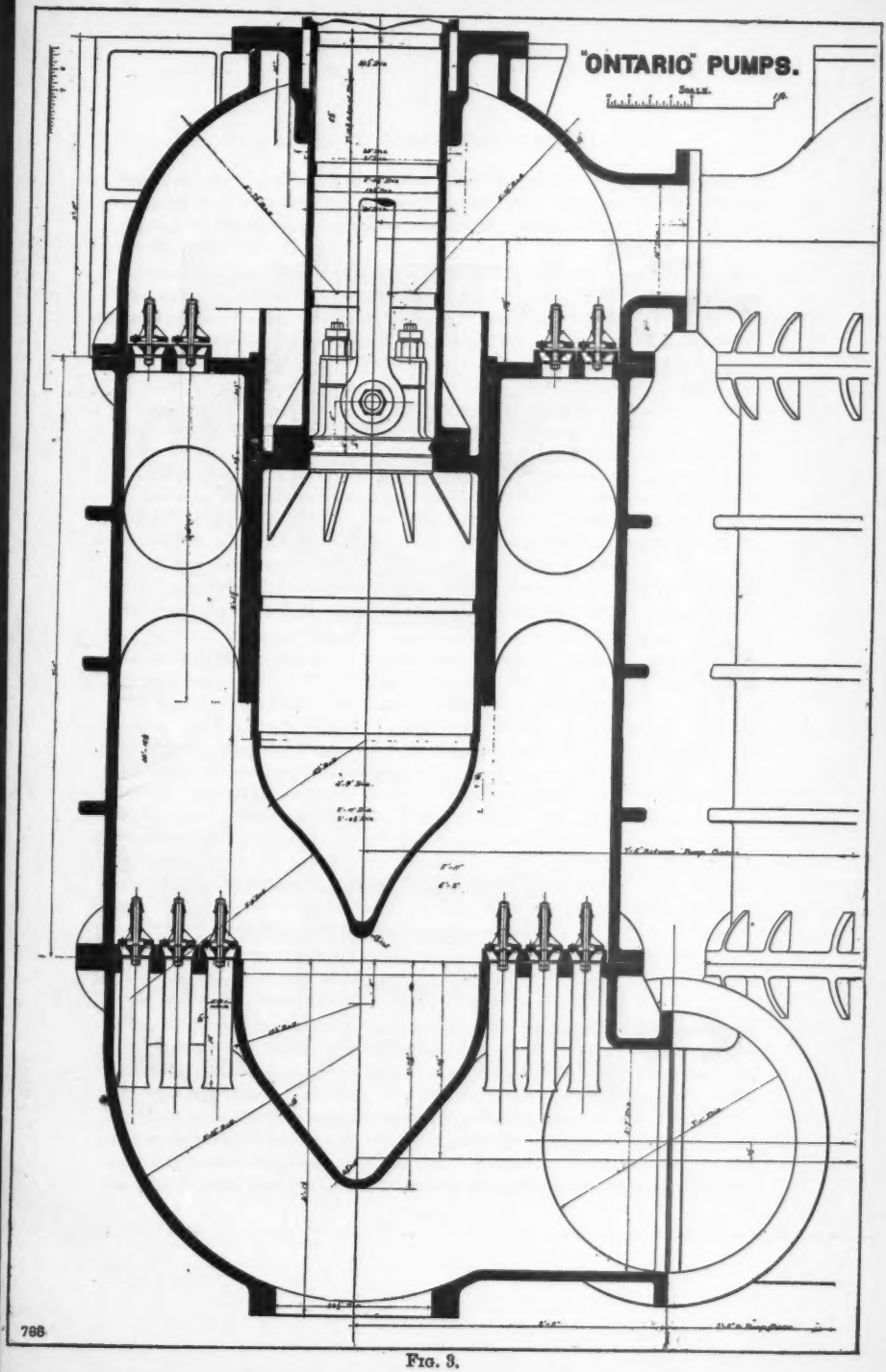


FIG. 3.

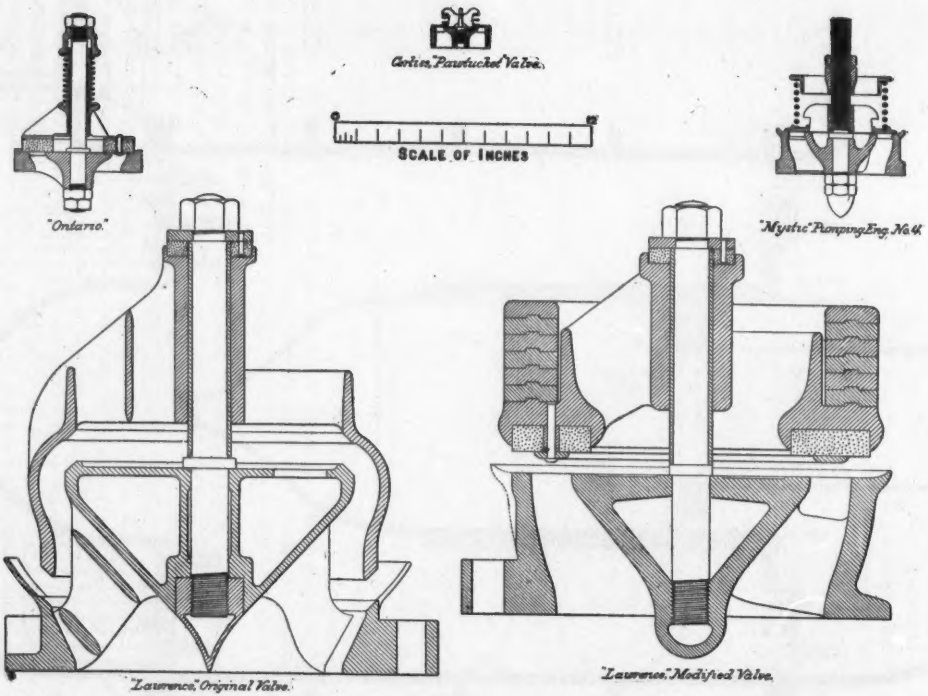

Corliss "Pawtucket" Valve.
SCALE OF INCHES
"Ontario."
"Mystic" Pumping Eng. No. 4.
"Lawrence" Original Valve.
"Lawrence" Modified Valve.

FIG. 4.

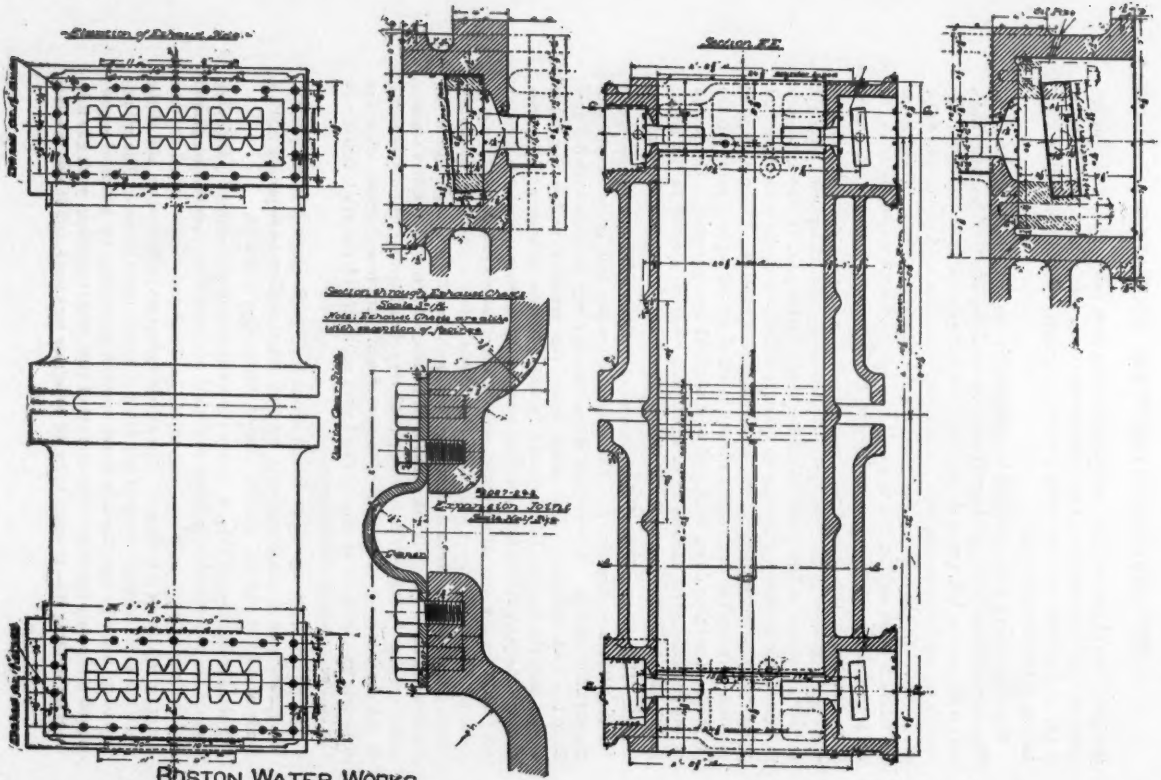
the ports, the object being to prevent distortion from heat. There is no higher grade of work done than has been put on these valve seats, and it pays, because it has been proven that the valves are perfectly tight without re-dressing, after having been in use 25 years.

The steam valve gear exhibited is substantially the same on all the engines. The valves are operated by cams placed on a revolving shaft. These cams have cast-iron centers, but the outer part which does the work is of steel, and the throws are hardened and operate on hardened steel rolls working on hardened steel pins. All the working parts have to be carefully ground. There is an adjustment made so that the two rolls can be properly brought together, in order that as the cam revolves it shall give a reciprocating motion to the valve. The advantage of this type of valve gear is, that it is possible with it to set each valve to do its work in the very best possible manner, something that I have yet to find any means of doing with any other type of valve gear. It is so expensive in first cost, that attempts have been made repeatedly to devise something that could be built more cheaply, but with indifferent success. The cut-off gear consists of a double cam, which gives a positive cut-off at any point of the stroke from nothing down to .9, and is controlled by a governor. The action of the governor gives motion to an arm which overruns a spiral in the shaft, and thereby turns the cam so that it closes the steam inlet valves earlier or later.

Plate VIII. gives an idea of the arrangement of the cylinders and reheaters for the Boston engine No. 3. The steam enters the high pressure cylinder through a separator. The exhaust steam from the high pressure cylinder goes into the first reheater. The outlet from the reheater is by the pipes shown, into the intermediate cylinder, in which it does its work and exhausts through the pipes shown into a second reheater, from whence it passes through pipes into the low pressure cylinder, and finally exhausts into the surface condenser. The reheaters are filled with small brass tubes in which live steam circulates, and a very decided advantage has been found from their use in the economy of the engine. It will perhaps be remembered that in the first engines that were shown, the cylinders were placed very close together, the object being to get short passages and thereby to save steam. But it was found, after the first test was made of an engine fitted with reheaters of this kind, that it was the best construction for economy.

One of the most expensive things about high-grade engines is the piping. We generally have a card catalogue for this detail, and we have people make a study of it for weeks and months, almost, before they master it.

The next illustration (Fig. 6,) shows the construction of a pedestal. Ordinary engines are considered to be good enough if the jaws of the pedestal are planed and the boxes planed to fit and slipped in. In the pedestal shown there are four boxes, as the thrust is horizontal. The side boxes are set up by wedges, and all the work has to be carefully scraped and fitted so that it bears all over. The adjustments are made so that the side boxes must all go square, by means of screws moved accurately together. The amount of time that is spent on work like this, in order to bring it as it ought to be, of course, is very large, and it also involves



BOSTON WATER WORKS.

HIGH SERVICE PUMPING ENGINE No 3.

STEAM CYLS. 13⅝ 24⅝ & 39×72 WATER PLUNGERS 12⅞×48

FIG. 5.

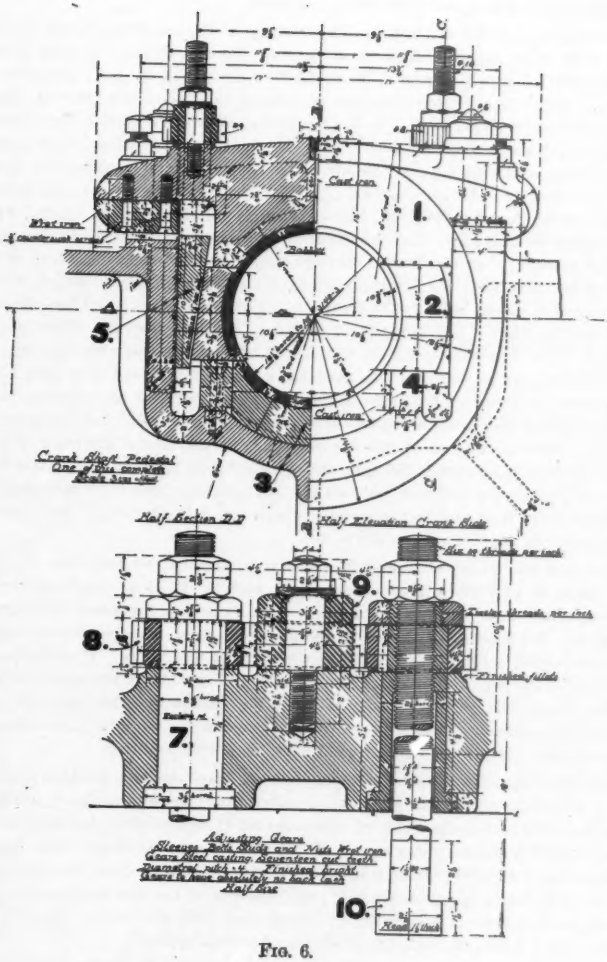

Cast iron.
Wrot iron.
Babbitt
Cast iron.
Half Section X Y
Half Elevation Crank Ends
1.
2.
3.
4.
5.
7.
8.
9.
10.

FIG. 6.

extra cost; but the work gives good satisfaction, as is proved by the fact that rarely with such fitting are there warm journals.

The table on page 179 will be found interesting, as showing some of the speeds which have been accomplished in advance of old-time ideas. It used to be thought that a Cornish engine of 10 or 12 feet stroke might make 7 strokes a minute. When the Brooklyn engines were built, they were run 10 or 12, they were 10 feet stroke, and such speeds prevailed. When the duplex engine was introduced, it was found that about 100 feet on a side was the proper speed, and it was almost considered heresy to talk of running an engine much faster than that. But you will observe that the I. P. Morris Company's engine, (the Lynn engine,) which had 7 feet stroke, had a piston speed of 252 feet a minute, way back in 1872 or 1873; and that the Lawrence engine had a piston speed of 256 feet per minute; that the Boston Sewage engine had a speed of 279 feet, with the large clack-valves; the Louisville Company's engine, 259 feet; an engine at the Calumet & Hecla, built by the West Point Foundry, which had 4 feet stroke, 296 feet; the "Erie," 351 feet; the "Ontario," 376 feet, and the "Michigan," 450 feet. The Pawtucket engine, which was one of the first very high speed of revolution pumps that ever was used had a speed of 250 feet, with only a 30-inch stroke; at Toronto, the Blake engine runs 280 a minute, and a second one 264 feet; while the Newton engine runs 250 feet. The firm of Jas. Simpson & Co. have built an engine of the Riedler type for the Grand Junction Water Works in London that runs 360 feet, and a second one, 270 feet. At Rotterdam there are two Riedler engines that run 360 feet a minute, and work noiselessly. At Berlin there is an engine that runs 350 feet. And so on, as you will notice, the speeds run anywhere from 250 to 450.

There is a very great advantage in running a pumping engine fast. In the first place, it permits a given amount of work to be done with very much smaller steam end. In the second place, the time is less for losses by internal radiation. It makes a very much more efficient engine. And again, the space occupied is less, and of course the first cost is very much less. It seems probable that in the near future pumping engines will run about the speed of mill engines, there will be no difficulty about it, and instead of the immense and ponderous constructions that prevailed in former days, we shall have engines of reasonable size, doing equally good work, and with less fuel.

In the East London Water Works in London, there are two Cornish engines which were built a good many years ago, called the "Duke" and the "Duchess." They have 100 inches diameter of cylinder and 11 feet stroke, and they pump about 9,000,000 gallons a day each. You will notice that the Lawrence engines which pump 5,000,000 per diem against a very much higher head than the London engines, had a speed of 256 feet; and the cost of the two engines, even of this high-grade type, was nothing in comparison with the cost of the others, taking in the whole installation, including the foundations.

The object of the illustrations (Fig. 7 and 8) is to show the action of the water in pumps by indicator cards. It has always been supposed that a slow speed would give a good pump card. These speak for themselves. The first card is

Pumping Engines Running Over 250 Feet Plunger Speed Per Minute.

Location.	Builder.	Capacity gals.	Stroke.	Revs. per min.	Plunger speed per min.	
Lynn, Mass.,	I. P. Morris Co., Philadelphia.	5,000,000	84 in.	18	252	
Lawrence, Mass.,	" "	5,000,000	96 in.	16	256	
Boston, Mass.,	Quintard Iron Works, New York.	37,000,000	108 in.	15½	279	Sewerage engines, 2 of this.
Louisville, Ky.,	I. P. Morris Co.	17,000,000	84 in.	18½	259	
Calumet & Hecla,	West Point Foundry.	5,000,000	48 in.	37	296	Minnehaha.
Calumet & Hecla,	I. P. Morris Co.	11,000,000	54 in.	39	351	Erie.
Calumet & Hecla,	"	20,000,000	60 in.	37½	376	Ontario.
Calumet & Hecla,	"	60,000,000	90 in.	30	450	Michigan, Largest pumping engine in the world.
Pawtucket, R. I.,	Corliss Steam Engine Co.	3,000,000	30 in.	50	250	
Toronto, Ont.,	Geo. F. Blake Mfg. Co.	3,000,000	30 in.	56	280	2 of this engine.
Toronto, Ont.,	"	12,000,000	48 in.	33	264	2 of this engine.
Newton, Mass.,	"	5,000,000	40 in.	37½	250	
London, England,	Jas. Simpson & Co., London.	16,500,000	36 in.	60	360	
London, England,	" "	16,500,000	27 in.	60	270	
Rotterdam, Holland,	Hannoverische Maschinenbau A. G.	6,000,000	36 in.	60	360	2 of this engine.
Berlin, Germany,	" "	7,500,000	42 in.	50	350	6 of this engine.
Gelsenkirchen, Germany,	" "	3,300,000	36 in.	60	360	Single plunger.
Barmen, Germany,	" "	2,500,000	42 in.	60	420	750 feet head; single plunger.
Hamburg, Germany,	Gutehoffnungshutte, Oberhausen.	7,000,000	48 in.	40	320	2 of this engine.
Ruhrort, Germany,	" "	2,250,000	33 in.	60	330	2 of this engine.
Eschweiler, Germany,	Ehrhardt & Schum Saarbrucken.	1,700,000	51 in.	52	442	Underground engine; 1,400 feet head.
Leipsig, Germany,	Sachsischen Maschinenfabrik.	5,500,000	39 in.	50	325	3 of this engine.
Zwickau, Germany,	" "	3,000,000	39 in.	60	390	2 of this engine; 600 feet head. Have been run at 80 revolutions.
Ludwigshafen, Germany,	Sulzer Bros. Winterthur.	3,800,000	30 in.	60	300	
Waldhof, Germany,	" "	3,800,000	30 in.	60	300	
Waldhof, Germany,	" "	5,000,000	36 in.	60	360	2 of this engine.
Brunn, Austria,	Fried, Wannieck, Brunn.	4,000,000	48 in	35	280	
Gratz, Austria,	Th. Schultz, Vienna.	3,000,000	31½ in.	60	315	
Buda Pesth, Hungary,	L. Lang, Buda Pesth.	7,000,000	48 in.	50	400	
Paris, France,	Farcot et Fils, St. Ouen.	4,300,000	70⅔ in.	30	350	
Boston, Mass.,	Quintard Iron Works, New York.	20,000,000	48 in.	50	400	

from an engine that is running 18½ revolutions a minute with a plunger speed of 119 feet a minute.

The second from a duplex engine at a speed of 132 feet per minute. This is decidedly better than the other, but you can see that the lines do not form a perfect rectangle.

The third is much better than the last. It is a card from the Milwaukee Allis engine, which I understand, is a 3-crank triple expansion engine. The pressure line is very good on each card, but the suction line is pretty wavy; speed, 204 feet a minute.

The lower card (Fig. 7) is a decided improvement over those above, and the speed here was 254 feet a minute, showing that it is not a matter of speed, but that it is a matter of pump construction. These really are very good cards indeed. The pressure here shown is 109 pounds, and in the lower card, 113.48 pounds.

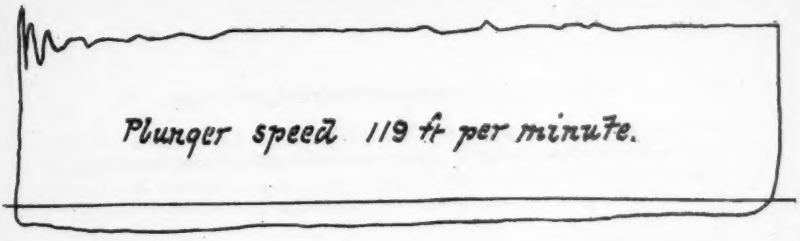
The first card on Fig. 8 is from the Louisville pumping engine, speed 259 feet a minute. The suction line is almost straight; there is a little wave on the corner. The originals can be examined, and these are not the best. We didn't dare to show the best card for fear you wouldn't believe it, and as they were taken by members of this association we didn't want to bring them into disrepute. (Laughter.)

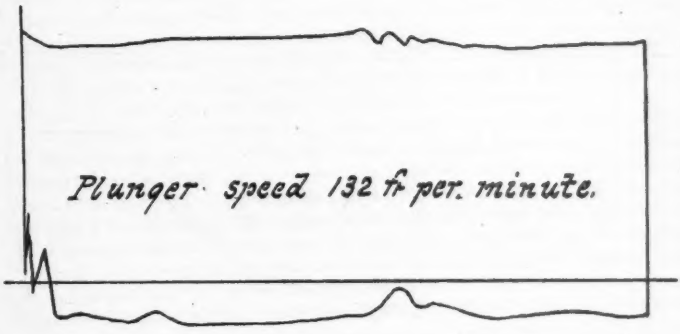
Fig. 8 also shows the steam cards from the Louisville engine. You will observe that the cut-off in the high-pressure cylinder is very early and that the lines are very smooth. This lower one is the low-pressure card. The consumption of steam per indicated horse power per hour is said to have been 12.17 pounds at the time these cards were taken, on a test of six days.

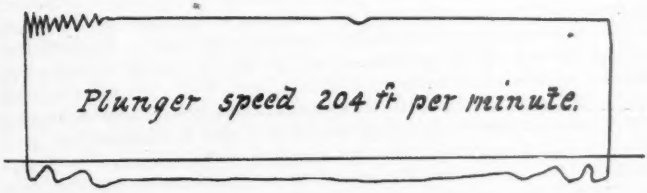
Of course in a pump card, the nearer it can be made a perfect rectangle, or the nearer it makes itself a perfect rectangle, the better the action of the water in the pump. Anything like pulsation in the card either shows a defect in the indicator, or strains in the pump and improper action of the valves. That is one of the things where great improvements have been made in pumping engines—a better understanding of the requirements of getting the water through a pump, having easy passages, abundant valve area, and valves which work with a minimum amount of resistance.

Of course a pumping engine has to have "feed," and in order to supply feed, we have to have a boiler. The boiler illustrated (Plate IX.) is of the type which has been extensively used by the Calumet & Hecla Company. It has also been adopted by the Newton Water Works, and has, I understand, given very satisfactory results; and I believe your secretary, Mr. Coggeshall, has some that he is willing to speak well for.

These boilers are of very large size. One of them is just about completed for the Boston High Service No. 3. They were made to carry a working pressure of 185 pounds per square inch. The shell plates are .8 of an inch thick, and you can see what an amount of staying it requires for the fire box. They are of the Belpaire type, and have two furnaces. Each boiler has about 3,000 square feet of heating surface. When burning soft coal, the furnaces have a fire-brick arch over the grate for about three-quarters of its length, which en-


Plunger speed 119 ft per minute.


Plunger speed 132 ft per minute.


Plunger speed 204 ft per minute.

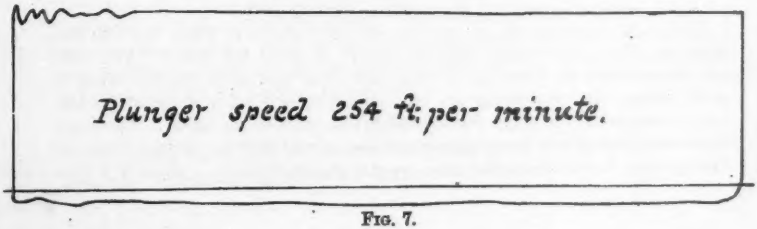

Plunger speed 254 ft per minute.

FIG. 7.

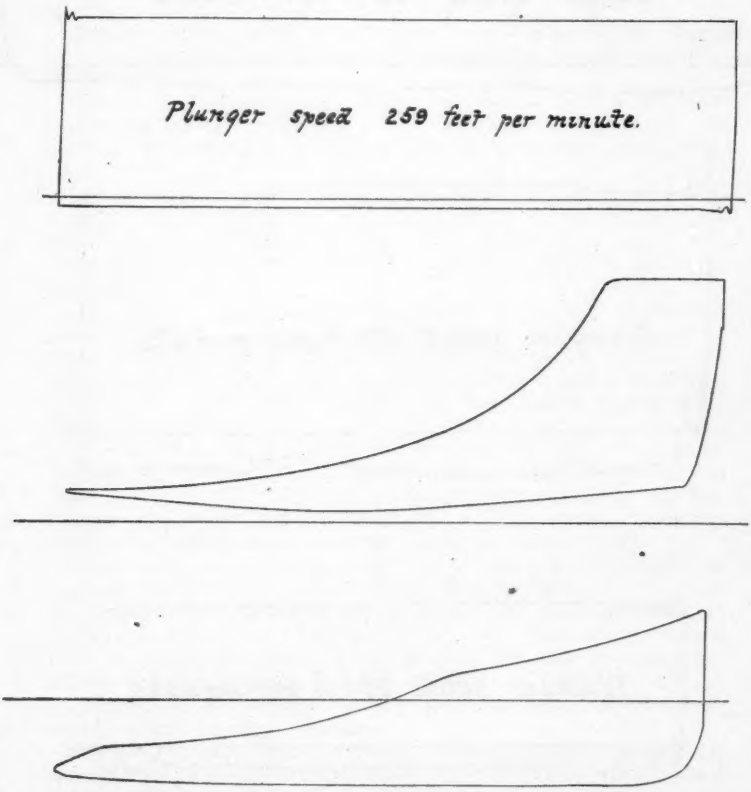


FIG. 8.

ables the volatile products of combustion to be well consumed. The weight of these boilers, exclusive of the castings, is about 45 tons.

The grate is placed on an incline, and the products from the two furnaces go into a combustion chamber before entering the tubes. The tubes are three inches in diameter, sixteen feet long, and there are 201 tubes in each boiler. The mountings are of steel. The feed water enters at the top, and is distributed by pipes running along the sides of the boiler. The upper view shows the crown sheet stays which are carried directly through from the crown sheet to the roof. The sides are also stayed by bolts. There is a man-

hole for entering the combustion chamber for cleaning out soot. There is also a mud-drum placed at this point for cleaning. These boilers have been found in practice with bad water to keep very much cleaner than the under fired type. The mud seems to accumulate near, and can readily be blown off at the mud-drum.

Fig. 2 shows first a section through the two furnaces, and the mid-water leg at the furnace door; and Fig. 3, a section through the combustion chamber just back of the water leg. The boiler has the stays so arranged that a man can crawl underneath them from one end of the boiler to the other, for examination, or to clean it.

Air is admitted both on the front end of the ash-pit and on the back, through a series of doors connected by rods and handles at the front end.

The boilers at the Boston Sewage Pumping Station, which are substantially of this type, though not having the Belpaire furnaces, have given an evaporation of very nearly 10¼ pounds of water to a pound of coal from the temperature of the feed. The Newton boilers give fully as good results, I believe, and the New Bedford boilers, (Mr. Coggeshall's,) even better than that. Altogether, the Calumet & Hecla Company have had over 40 such boilers as are here shown. The first cost is very great as compared with the under-fire type, but they have proved in the long run to be the cheapest boilers. They cost scarcely anything for repairs. The first boilers were built in 1878, have been in continuous use since, night and day, except Sunday, for the greater part of the time, and and are still good. And that is a very important matter in a municipal plant where the service is always going on.

I will conclude my remarks by a little further allusion to tests. The modern method of making pumping engine tests is something that is past finding out. We hear of engines that are just like other engines that we know all about, that will do on a duty test twice as much duty as we can possibly get out of ours. But when you come to analyze it, you find that the test was very short, and the allowances were of a kind that a man to understand them must be thoroughly acquainted with the differential and integral calculus, and then after he has become well acquainted with that, he has got to study chemistry and take an extra course in some college in thermo dynamics, and even then it is doubtful if he can figure it out the way the professors will do it. You, gentlemen, have to deal with the financial part of the problem, and I think it is not asking too much to suggest to you that you put your foot down for long tests, and that you take the coal pile at one end, and the reservoir at the other. The pounds of water or the gallons of water that are delivered into the reservoir by the consumption of a given amount of coal, represents all the engine's duty that is of any value to the owner of the engine. And while, as I said before, these very fine and hair-splitting tests are perhaps interesting scientifically considered, they are of no earthly use to the owners of the engine. I thank you, gentlemen, for your kind attention. (Applause.)

DISCUSSION.

MR. GOULD. I believe Mr. Leavitt was going to tell us later his reasons for changing his opinion in regard to a triple crank engine.

MR. LEAVITT. I said I would, and will do so. I found in Europe that it was almost the universal practice to use coupled engines, that is, on the Continent, and especially where pumps are run at high speed. It didn't occur to me at the time that there had been anything phenomenal in the way of high speed in this country, that is, we hadn't got up to any such speeds as we have developed subsequently. I made an arrangement with Prof. Riedler in 1889, to construct some pumps on his system. On my return to Cambridge it occurred to me one day that we had had a pump that ran fast, and I set the people in the office to hunting up some old drawings, and a pump was brought out that was built in 1876, had run continuously night and day for several years, at a speed of 500 feet a minute, and it was a single-crank, differential pump. The "Ontario" was not running then at the high speed it subsequently did. After seeing that engine run, it seemed to me that there was no need of having three cranks when one would do, because it saved so many journals. Prof. Riedler, on the contrary, was very much in favor of the multi-crank engine; but Mr. Mattice went to Europe two years ago, looking around after pumping engines, and the finest engine he saw was a single crank engine running at a speed of 80 revolutions per minute, and that turned the scale in my mind in favor of the single crank.

It is just as easy, in fact it is simpler and costs less money, to build an engine of the "Michigan" type, than it does a 3-crank engine. The Boston engine had to be of just such a size in order to go into the space, but I am not certain if the job were to be undertaken today, that I should not urge the city to go outside the house and put the engine in a new building, with a single crank, simply because it takes fewer parts. The new Cambridge engine which is about to be undertaken will be almost a duplicate of the engine "Michigan," with the same stroke, but larger steam cylinders, because the power will be greater. Another thing, it seems to me, is that we can get with a single crank a better pump card than was formerly thought possible. I have had no faith in crank engine pump cards until within a few days, when I saw for the first time the cards of the Louisville engine. I have told you all I dared to about them, and if you want to know more, you must ask the persons who are responsible, Mr. Dean and Mr. Brackett. (Laughter.)

MR. DEAN. As my name has been brought up in connection with the test of the Louisville engine by Mr. Leavitt, it may be interesting to say something with reference to that. The engine is one of very great interest on account of its enormous size and enormous weight, partly brought about by the situation on the Ohio River, where the rise and fall of the water is so great as to make it necessary to have the distance from the bottom of the pump to the bottom of the bed-plate 61 feet. The test is very interesting in consequence of its duration, which was six days and nights without stopping. I think it is the longest test on record. I think the feature of tests, which Mr. Leavitt has mentioned, that they should be of great duration is very important; and this test of six days is to be exceeded at St. Louis by tests of thirty days of a number of engines which are now being built.

This Louisville test is also very interesting in consequence of the consumption of steam by the cylinders, as it is a compound engine. It surpasses, so far as I know, any record that has ever been made, using per indicated horse power 12.16 pounds of dry steam, and as there was only one-half of one per cent. of moisture in the steam near the engine, the engine being about 180 feet away from the boilers, the actual consumption of feed water is very small indeed. The possibility of a compound engine using so little steam as this has been a matter beyond the belief of anybody who has had to do with steam engines; and I have been very skeptical myself in regard to the performance of some recent compound engines which have been built by the Wheelock Engine Co. engines known under the name of the Rockwood system. I was applied to to make a feed water test of such an engine a short time ago, and I found it came up to the guarantee made of 12.8 pounds of dry steam per horse power per hour. I am not very superstitious about the performance of steam, and I think I have always been conceited enough to think I knew what made economy in steam, and I thought that in the case of the Rockwood engine it was not necessary to look to any special Providence that was in favor of the Rockwood system, but that the economy was due to high steam and tight valves and small clearances. The details of the Louisville engine having been carried out so much more perfectly than they were on the Rockwood, I anticipated a result from that which would be superior to the Rockwood engine, and so it turned out. On the test I made I confess that the engine might have done better if certain things had been done, but it came out 12.8 pounds, and the Louisville 12.16 pounds.

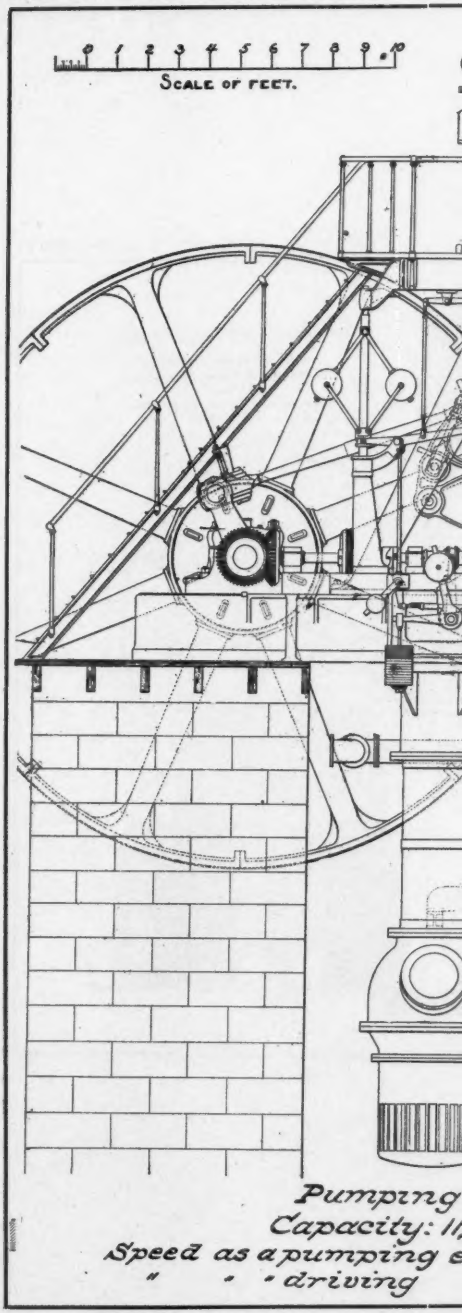
The Louisville test was also very interesting on account of the low friction for such a ponderous machine, being 6.88 per cent. That is the percentage which has been almost characteristic of direct acting engines which have no fly wheels, link journals, connecting rod journals and so forth, but it now appears that a fly wheel engine can do as well as most of the direct acting engines. In fact, that had been previously shown in the case of the Corliss engine at Pawtucket, and also in the Newton engine.

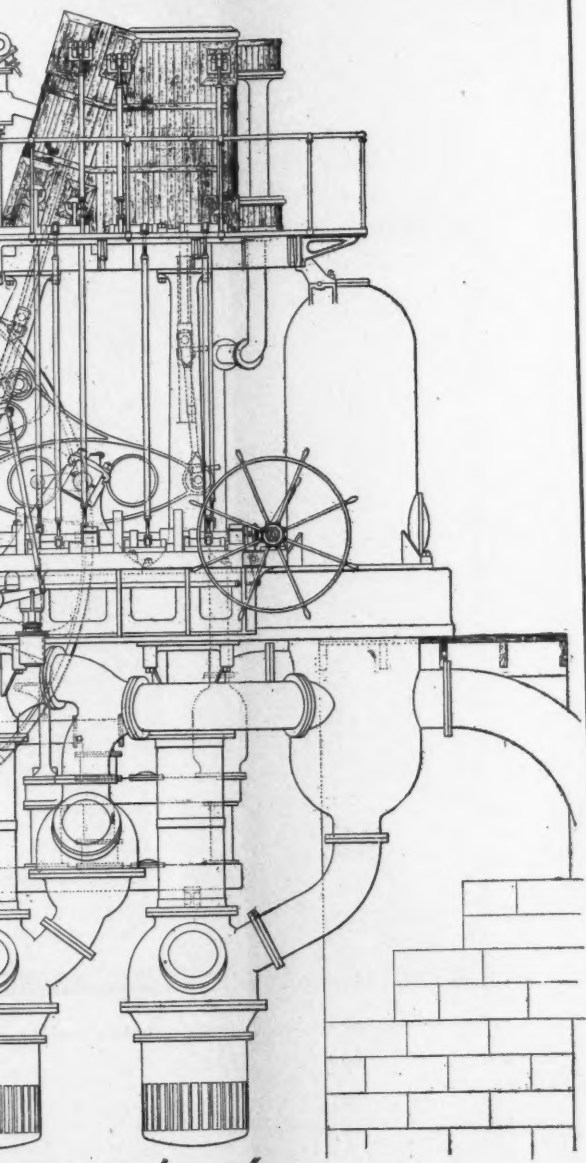
In regard to the pump cards, I am rather sorry that Mr. Leavitt didn't show the best cards as well as those he did show, in order that you might see for yourselves how Mr. Brackett and I can misrepresent things, or make cards to suit ourselves. (Laughter.) But we think it was a fact that once in a while the pump would take a better card than those Mr. Leavitt showed; we think also we might have run the pencil over more than 17 times on those he showed without having more than one line. Mr. Leavitt might have shown, if he had been furnished with the material, a card or two from the steam end, in which one line was made by some 20 repetitions of the pencil, showing a very exact action of the valve gear and the very good controlling effect by the governor—the constant point of cut-off. That is possible, of course, only in the case of a pumping engine which was pumping against a certain constant head. In the case of the Louisville engine the head varied almost none in the six days, so if the engine was a really good engine on the steam end, and the indicators were really good, they ought to have shown a card which would be a constant repetition of itself.

I am very much in sympathy with Mr. Leavitt's view that pumping engines can run fast, and I am very glad that he does not think it is necessary to use the Riedler valve gear to produce that result, because that brings the possibility of making small pumping engines, and rapid running ones, within the range of people who don't control patents. It lets us all into the field.

The matter of boilers has been touched upon. I never have made it at all a private belief of mine that I am very much in sympathy with the internally fired boiler, and particularly with the locomotive type; and I think it will be found right along that the internally fired type when compared with the externally fired will use about 10 per cent. less coal to evaporate a certain amount of water. And I was very much pleased the other day to see that Mr. Isherwood, in one of the monthly meetings of the American Society of Mechanical Engineers, stated he had found it to be so over and over again.

I must make a plea for some features of tests, which Mr. Leavitt does not seem to value as much as I do. While I am in hearty sympathy with him in regard to the importance of the coal pile and the reservoir, (everybody pays for coal, and they pay for an engine which is to deliver so much water into the reservoir; there is no question about that, and if the engine will not do the work, nobody wants it) yet, on the other hand, I don't think the superintendent of the water works or the city authorities should prohibit the engineer from making tests which show the niceties of the engine or the pump, which show how much steam per indicated horse power per hour the engine uses, or exactly how much water the boilers will evaporate per pound of coal. The efficiency of the mechanism, that is the determination of the friction of the engine, how much the duty will be if certain other things were the case, how much the duty is on 1000 pounds of dry steam, how much it is on 1000 pounds of feed water—if we know those differences we can see very plainly the effect of improving the boiler performance, or of the use of a seperator, for instance, which would do the work advantageously of separating the water from the steam. I believe myself that experts who are making pumping engine tests are really rendering a very great service to the steam engineering profession, and indirectly to the superintendents of water works, and to the people at large who furnish the money to build these things. It may not be apparent at any particular time, but it is in the line of progress of making everything better. And we know that everybody is striving to improve pumping machinery and everything else. While we are aware that many things are being very cheaply made, and many people are advocating cheap things on some accounts, it is a very common thing for us to hear people asking in some manner to have things better. People will come in and say, "We want the best thing, but we don't want to pay too much money for it." There is, I am happy to say, a very high standard in the minds of the majority of people. We are so constituted that we like good things. We are also so constituted that our pocket books are limited; but I am very glad to say that our standard is beyond ourselves, and that we are constantly, let us hope, following the lead of our standard. We are going up hill all the time and not down. (Applause.)


0 1 2 3 4 5 6 7 8 9 10
SCALE OF FEET.
Pumping
Capacity: 11
Speed as a pumping e
" " driving



g Engine "Erie".
11,000,000 Gallons.
engine 39 revs. per minute.
" 50 " " "

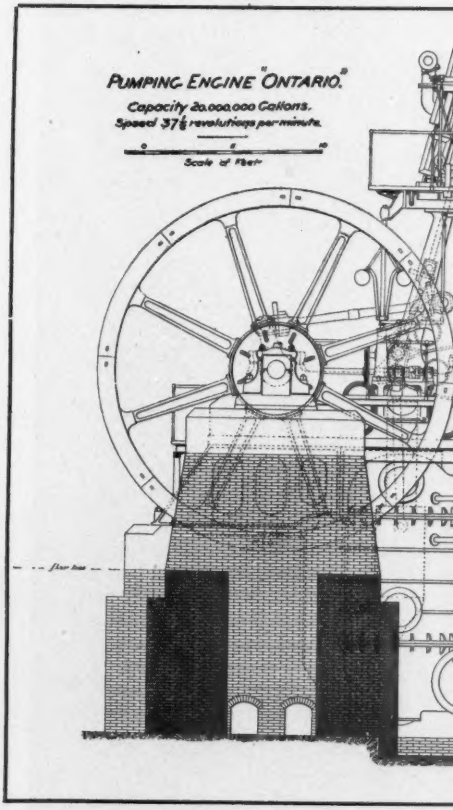
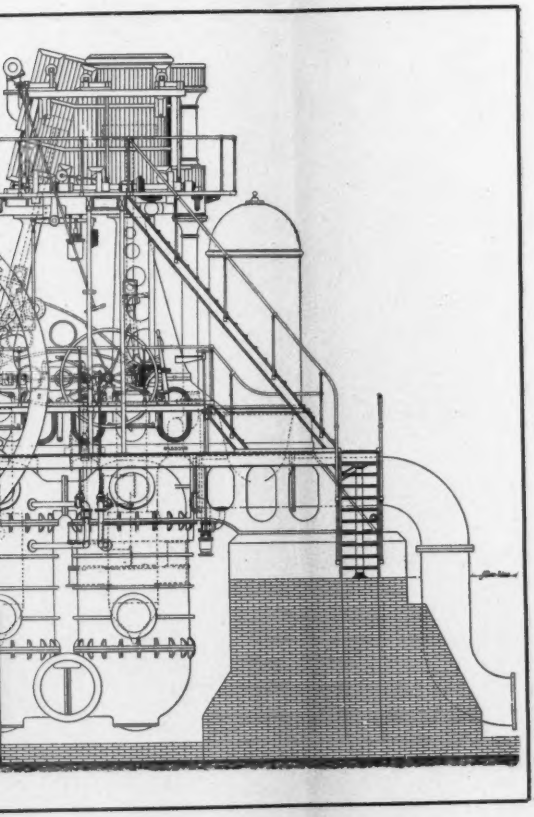

PUMPING ENGINE "ONTARIO."
Capacity 20,000,000 Gallons.
Speed 37½ revolutions per minute.
Scale of Feet
floor line

PLATE II.



Pumping
Capacity; 20,000,000 gal

g Engine "Michigan."
gals. Speed; 30 revs. per min.
0 20
Scale of feet

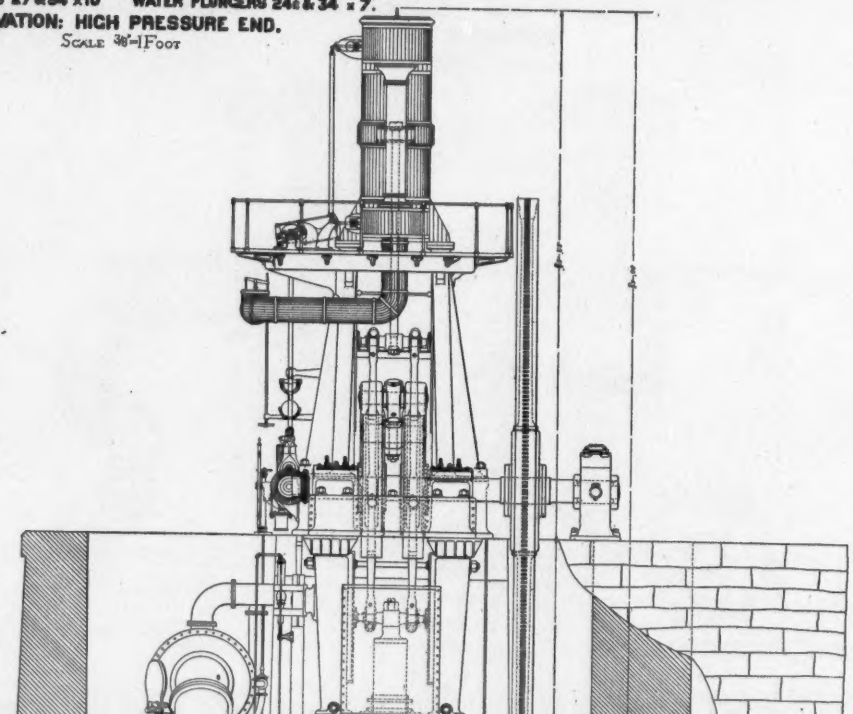
LOUISVILLE WATER Co.

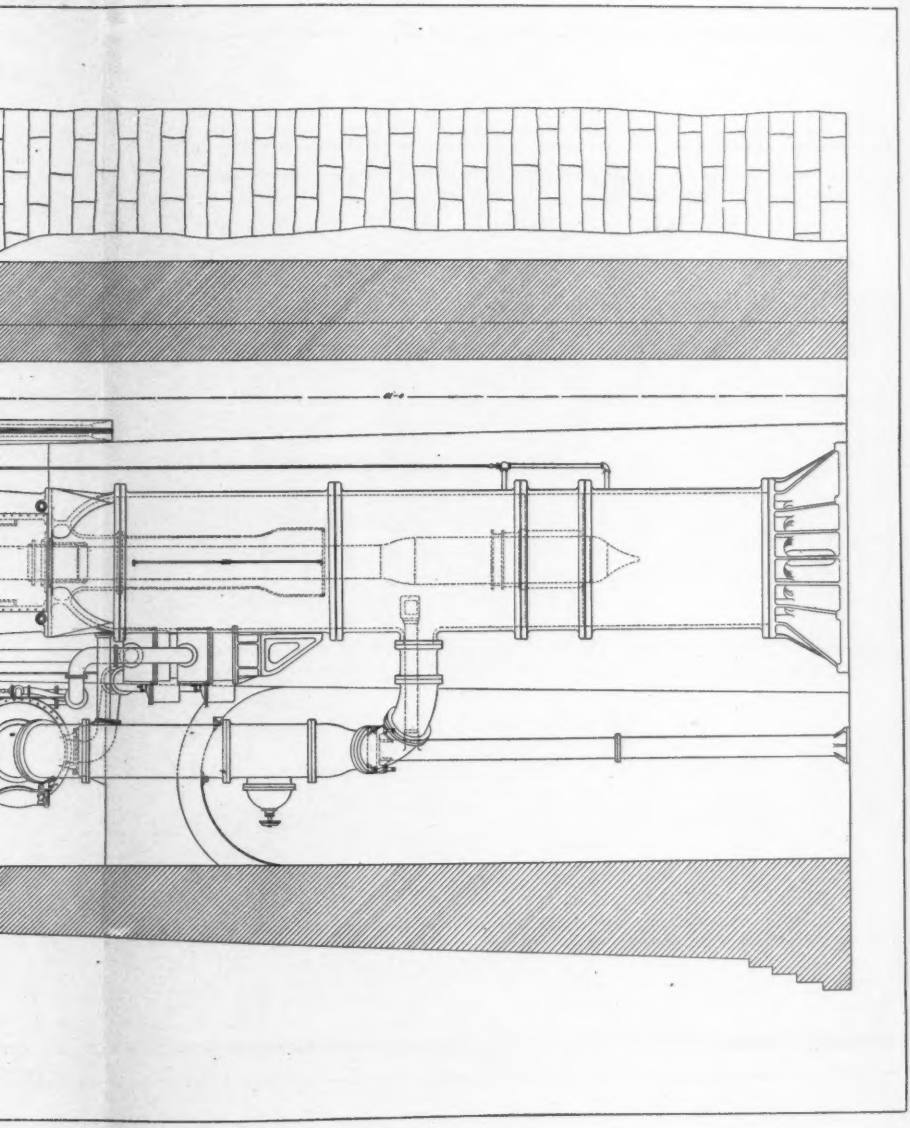
PUMPING ENGINE No 3.

STEAM CYLINDERS 27"&54"x10' WATER PLUNGERS 24½"&34"x7'.

ELEVATION: HIGH PRESSURE END.

SCALE ⅜"=1FOOT



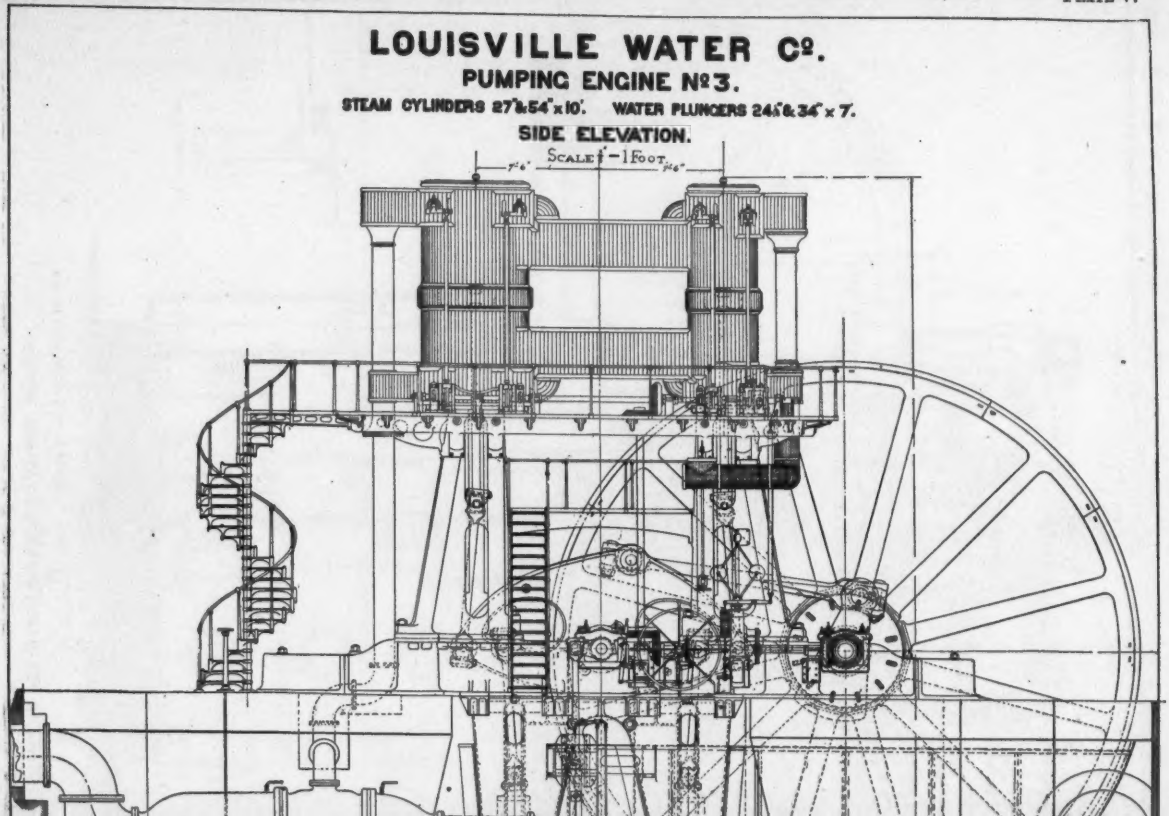


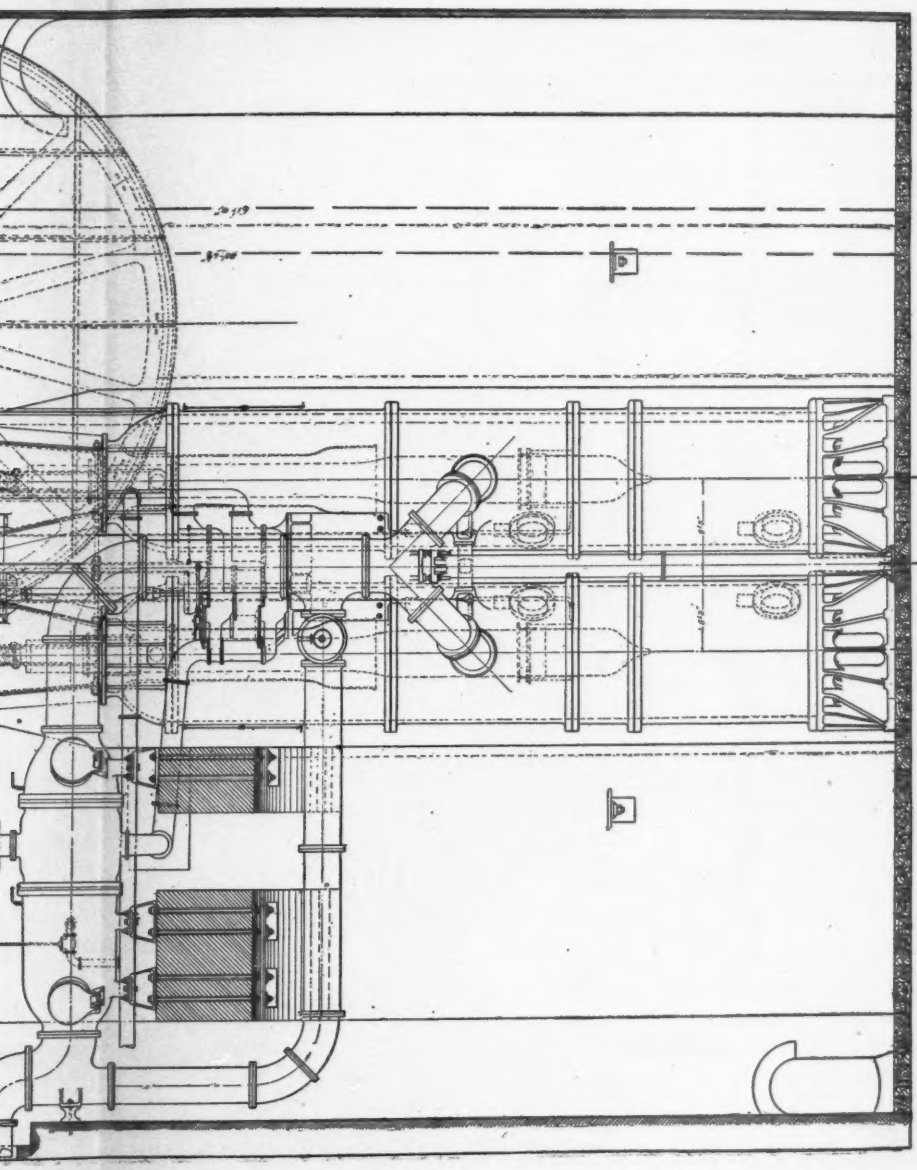
LOUISVILLE WATER Cº.

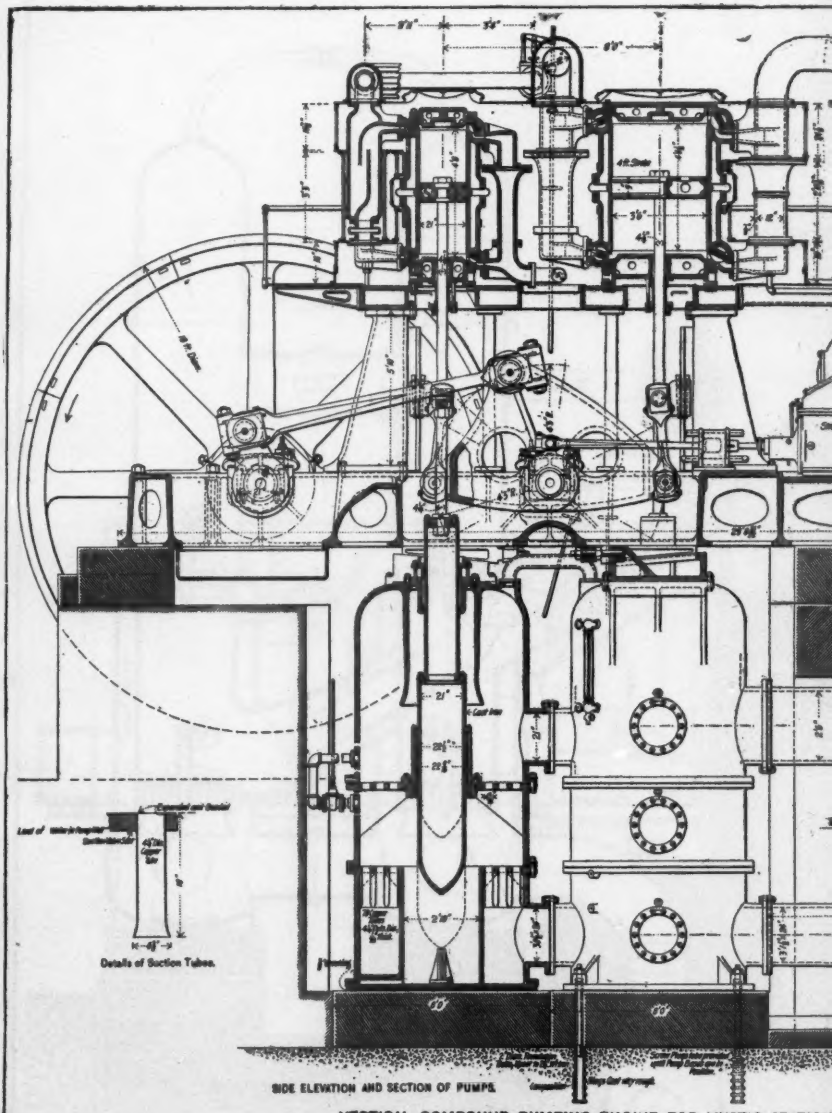
PUMPING ENGINE Nº 3.

STEAM CYLINDERS 27"&54"x10'. WATER PLUNGERS 24.5"&34"x 7.

SIDE ELEVATION.

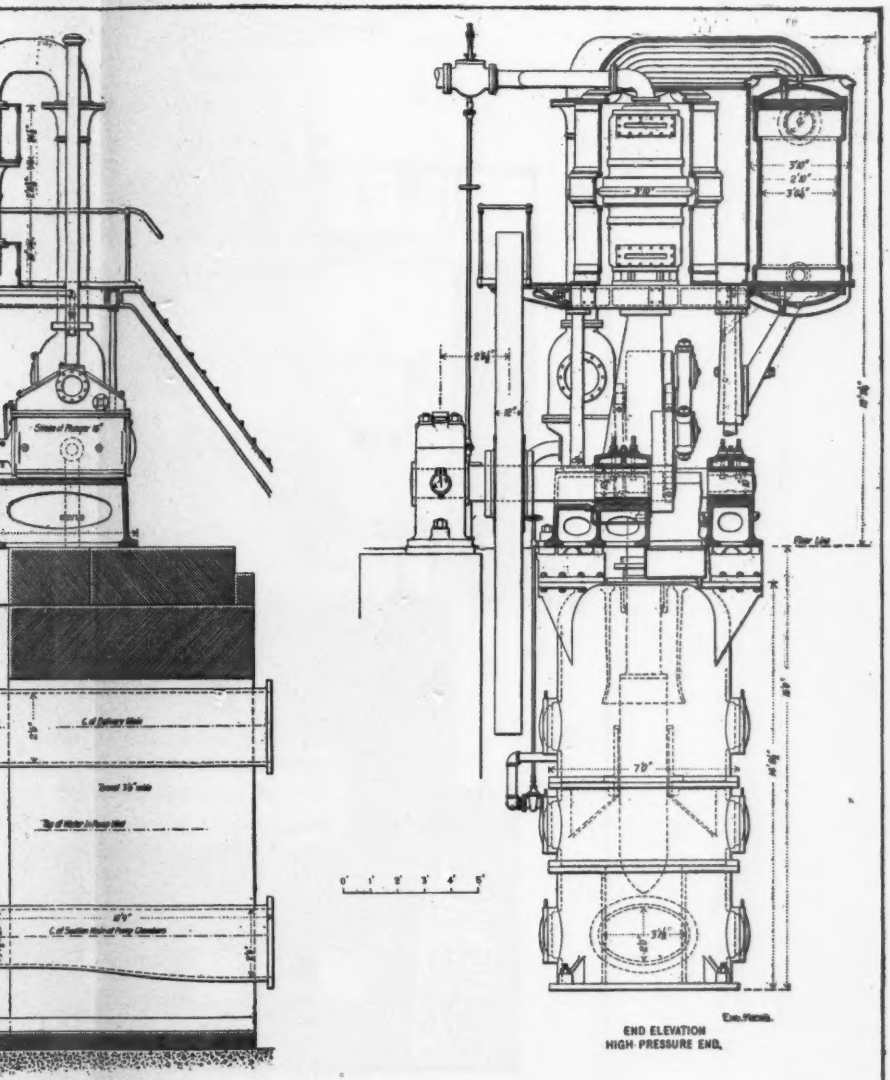






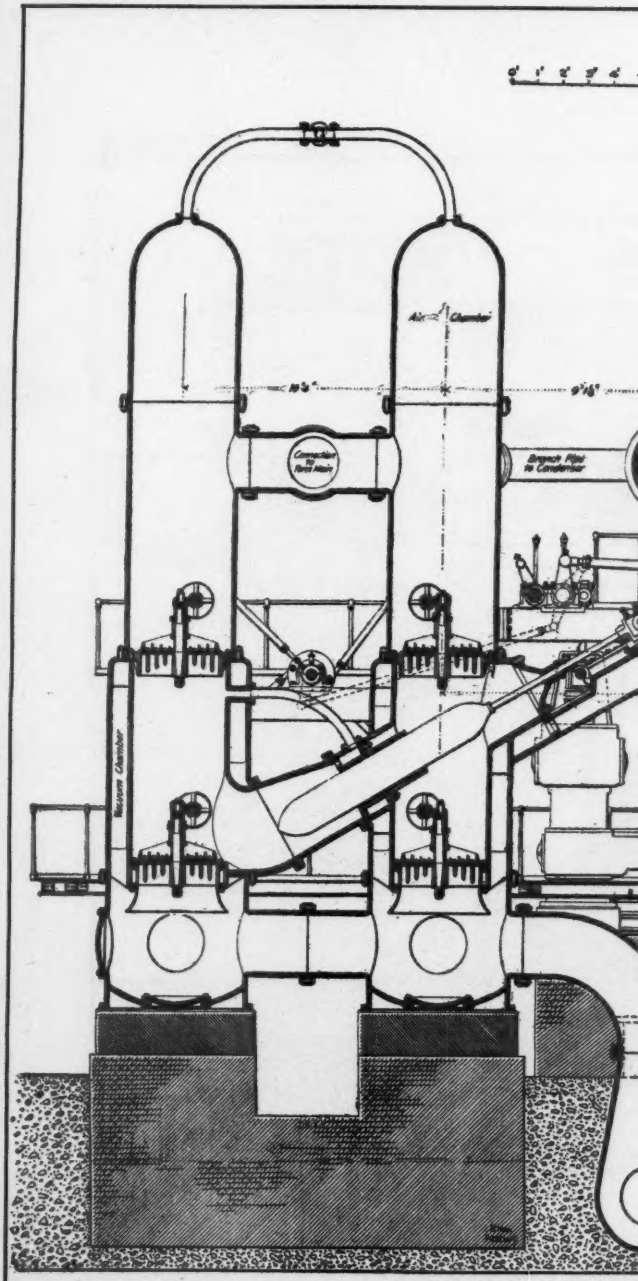
VERTICAL COMPOUND PUMPING ENGINE FOR MYSTIC STATION

E. D. Leavitt, M. Am. Soc. M. E., Consulting Engineer. Wm. Jackson, M. Am.

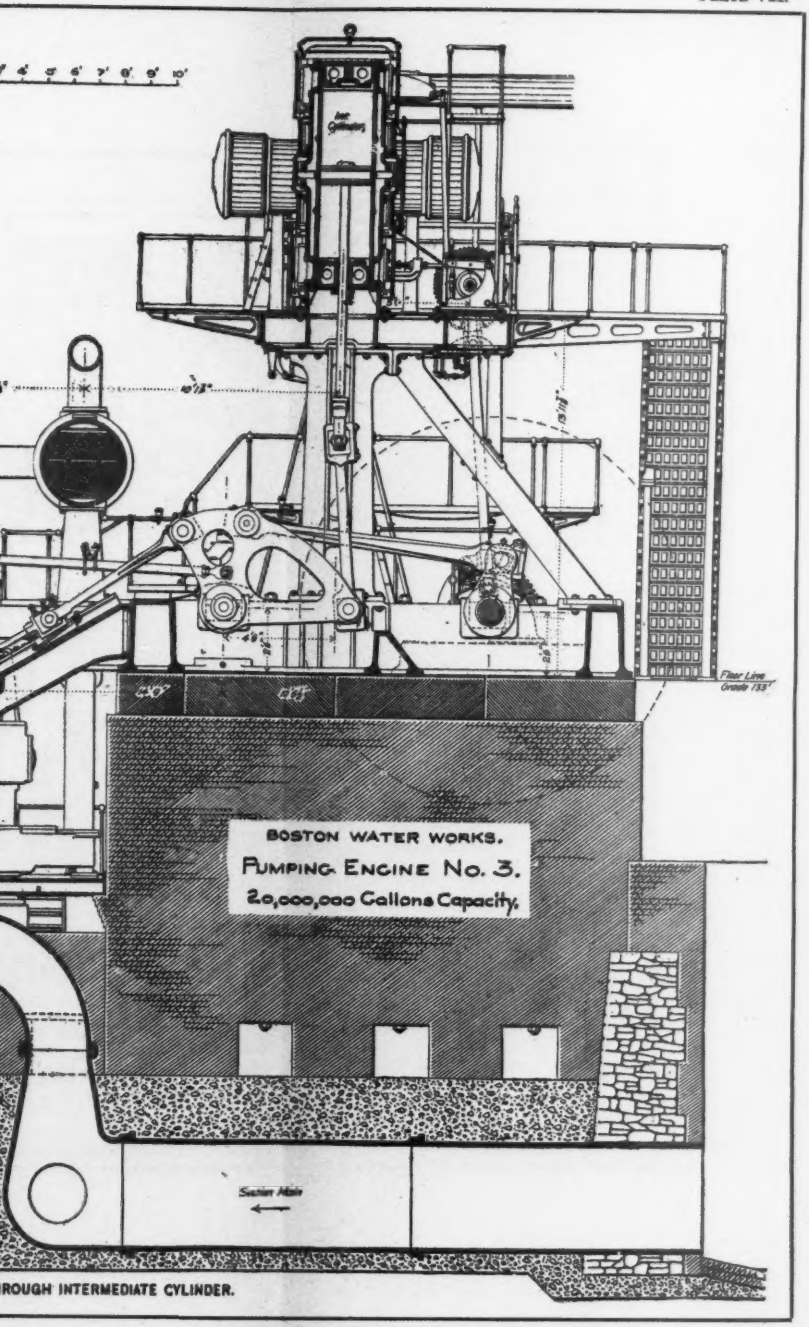


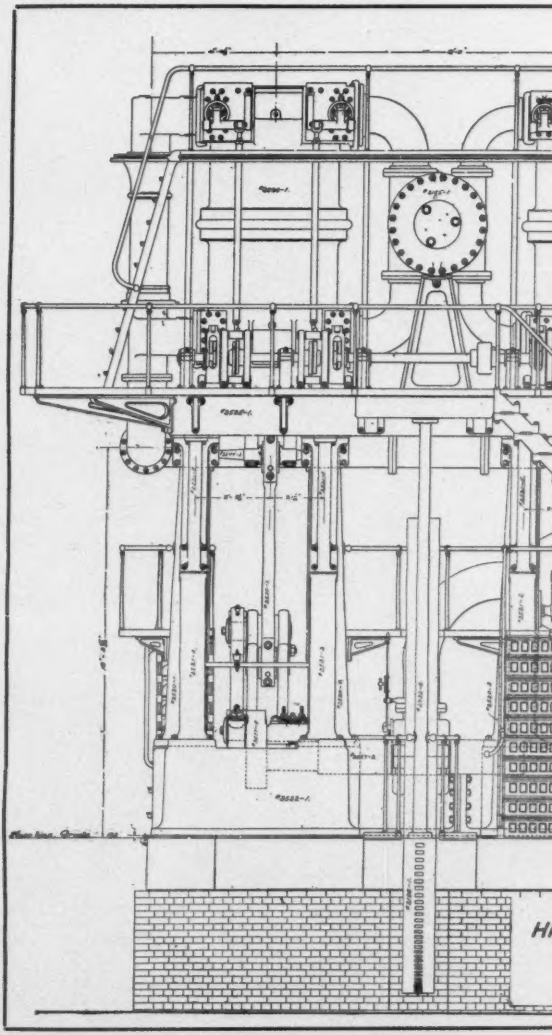
END ELEVATION
HIGH-PRESSURE END.

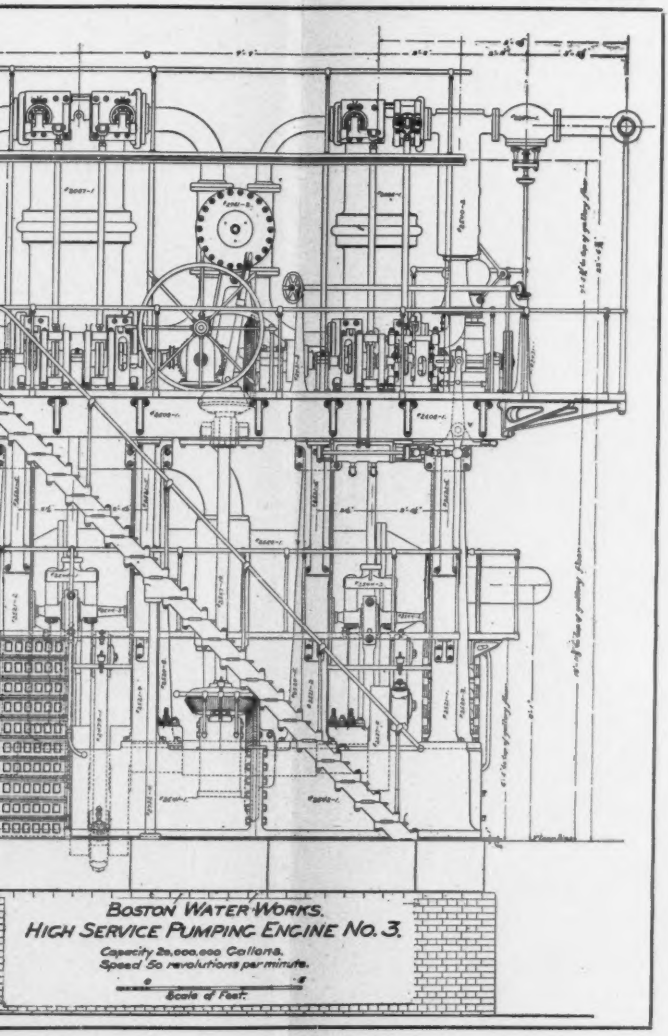
TATION, BOSTON WATER-WORKS; DAILY CAPACITY, 10,500,000 GALLONS.
M. Am. Soc. C. E., City Engineer of Boston. The Geo. F. Blake Mfg. Co., Contractors.



VERTICAL SECTION THROUGH


BOSTON WATER WORKS.
PUMPING ENGINE No. 3.
20,000,000 Gallons Capacity.
Suction Main
ROUGH INTERMEDIATE CYLINDER.





BOSTON WATER WORKS.
HIGH SERVICE PUMPING ENGINE NO. 3.
Capacity 20,000,000 Gallons.
Speed 50 revolutions per minute.
Scale of Feet.

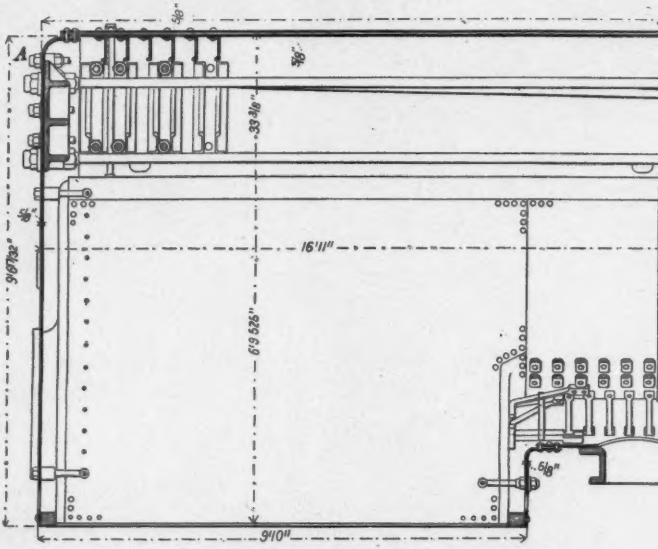


FIG. 2

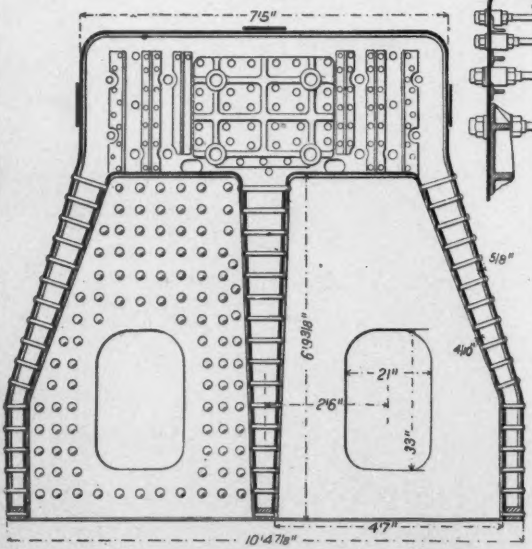


FIG. 5

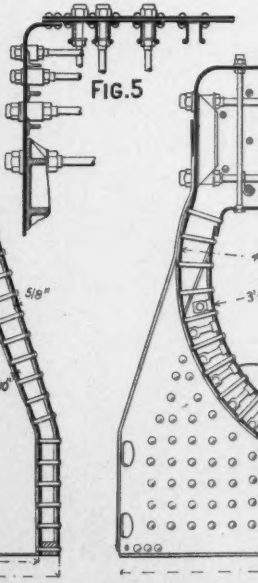


FIG. 1

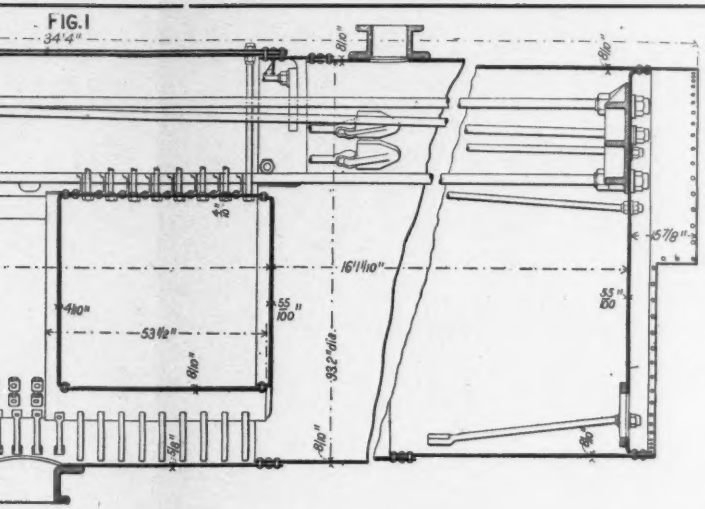


FIG. 3

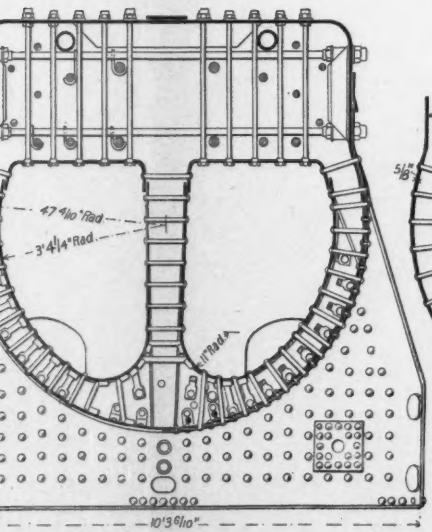
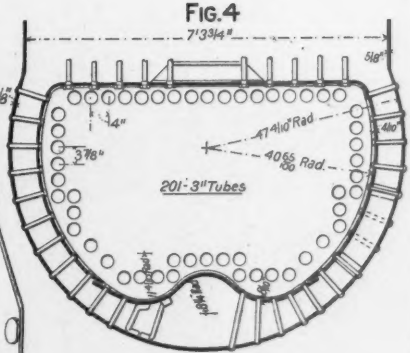


FIG. 4



THE ENGINEERING RECORD

A METHOD OF CONNECTING LEAD SERVICES.

BY

W. F. CODD, SUPERINTENDENT, Nantucket, Mass.

[Read Jan. 9, 1895.]

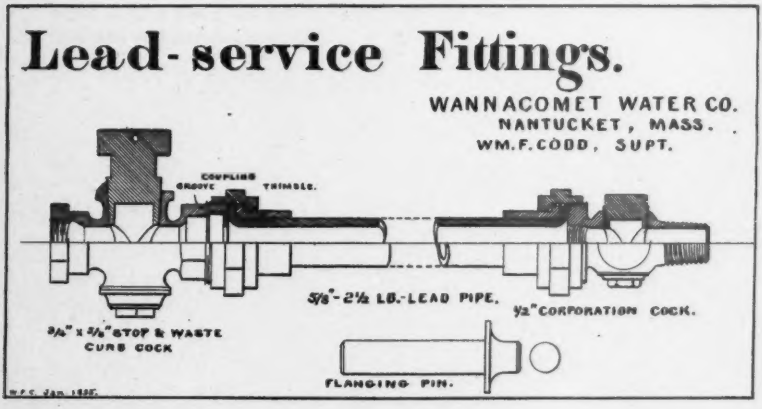
This is a matter that will be more particularly interesting to managers of small water works, where the business is not sufficient to warrant the steady employment of a plumber, and yet who think it best to keep their own workmen, to lay the services. The ordinary workman, who can cut and fit iron pipe, often not being skilled enough to make wiped joints.

At our works, we have decided that lead pipe makes the best services, for us, and we always made the connections with the cocks by wiped joints, which are open to the following objections :

They are best made in the shop, and to do it, it is necessary to cut the pipe to length—after the trench is opened, causing delay—and, after being made up, if too long, a waste of pipe ; if too short, more soldering is necessary.

If the solder is too coarse or fine, as often occurs, the joint weeps or is otherwise unsatisfactory; and if it requires resoldering, behold, the plumber is gone on another job, by that time, or if at hand, finds trouble in wiping the joint over again in a wet trench, or in a high wind.

Also, the expense for solder and labor is a large item. To obviate these troubles, the present form of corporation and curb cocks has been devised.



Very likely you are familiar with it, already, as I am so far out of the world that I do not always keep track of what the others are doing.

The apparatus is simply a thimble and union nut, fitted to the ends of the cocks.

The lead pipe is passed through the thimble and flanged over on to it, and then the union nut is screwed on to the cock, fastening all together firmly, the lead flange forming a washer. The operation is simple and easy. Anyone can learn it, and the joint can he made under water as well.

One end of the coil of pipe may be joined to the curb cock and the coil unrolled in the trench as fast as the trench is dug and when the corporation cock is reached, cut off at just the right length, and the other joint can be made in no time.

The only tools needed for the whole job are lead pipe cutter, expanding pin, hammer and wrenches.

The cost of the cocks, thus fitted, is but a trifle more than the cost of ordinary cocks for that purpose.

If any fittings are found defective, after the water is turned on, it is very easy to unscrew the union joint, replace the defective by a perfect cock, and connect up again.

We have used them a year and like them very much.

DISCUSSION.

QUESTION.—If those joints are once broken can they be made perfectly tight again without repairing the pipe?

ANSWER.—Yes, we find no trouble in that respect. The lead is soft enough to screw up with very little pressure and make the joint tight.

QUESTION.—How much pressure have you got there?

ANSWER.—About forty pounds.

OBITUARY.

PHINEAS BALL.—Civil Engineer, Worcester, Mass. Died Dec. 19th, 1894, aged 70 years and 11 months. Joined this Association June 16th, 1886.

Mr. Ball had been engaged in the practice of his profession since 1847. He designed and built the Springfield, Mass., Water Works, and extensions of the Worcester Water Works and Sewer System, and planned among other works the Brockton, Mass. Water Supply and Taunton Sewer System.

Mr. Ball was elected to many offices of honor and trust by the citizens of Worcester, among others, Mayor, Water Commissioner and City Engineer. He was president of the Union Water Meter Co., and patented many devices used by that company in the manufacture of meters.

He was an active participant in the work of this Association and its discussions, and his genial and kindly nature won him many friends among its members who will mourn his death.

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The Leading Water Meter Manufacturers of the World!

139,000 Meters

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EMPIRE

WATER METERS

NATIONAL METER CO.,

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THE WORTHINGTON WATER METER.

Used by the Water Companies of the United States and Canada for over FORTY YEARS and pronounced by them

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All parts constructed of Iron and Brass.

The Counter movement is not exposed to the action of the Water.

Positive in operation.

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Accurate in Registration.

Hot Water Meters, Oil Meters, Meters for Naphtha, Alkaline Liquors and Special Services.

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BROOKLYN, N. Y. and ELIZABETHPORT, N. J.
Established 1845.

a. d. m. j.

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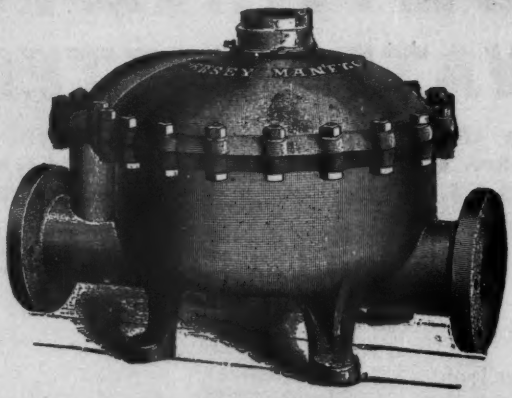

WATER METERS

—AND—

Water Works Appliances.

Our goods are scattered throughout the WORLD and have reached nearly every department in the United States where meters are used.

We have established Agencies for the convenience of distant customers as follows:

CHICAGO:
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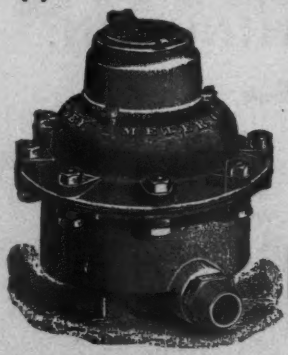

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South Boston, Mass.

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SOLE OWNER LAMBERT-THOMSON METER PATENTS.

THE LARGEST EXCLUSIVE

WATER METER MANUFACTURERS

IN THE WORLD.

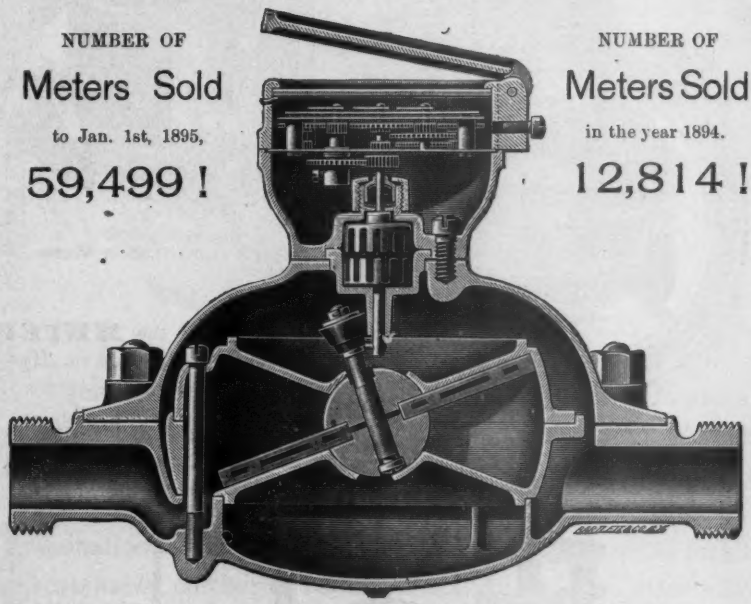
79-83 WASHINGTON ST., BROOKLYN, N. Y.

NUMBER OF

Meters Sold

to Jan. 1st, 1895,

59,499 !



NUMBER OF

Meters Sold

in the year 1894.

12,814 !

SECTION OF THE ¾ INCH SIZE BEE METER—HALF SIZE.

The use of the steel plate in the disc was discontinued June 26th, 1894.

NO METAL OTHER THAN

BRONZE, COMPOSITION, BRASS AND GERMAN SILVER

is used in the manufacture of this meter.

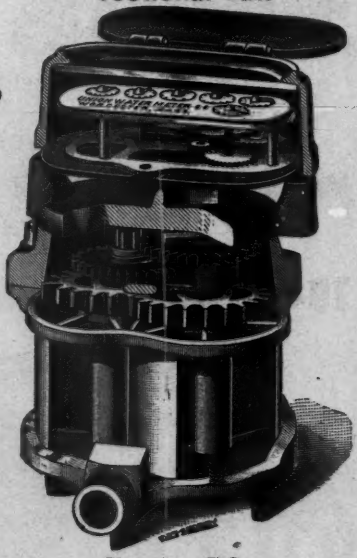
s.d.m.j.

UNION WATER METER CO.,

WORCESTER, MASS.

ESTABLISHED IN 1868.

Sectional Cut.



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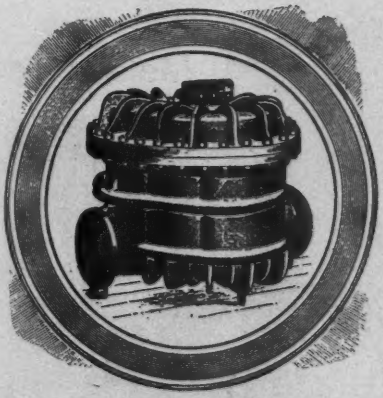
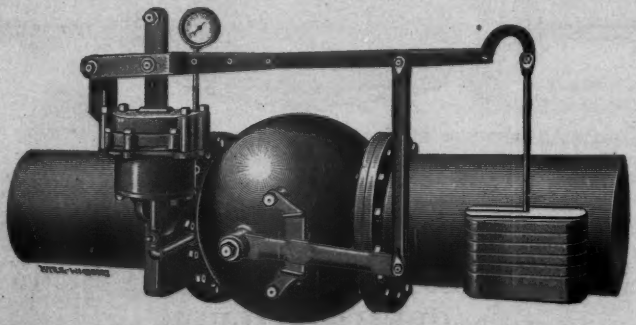
Union Rotary Piston Meter.



Extra Heavy Rotary Piston Meter.

Manufacturers of the **METER** most extensively used on Hydraulic Elevators, Locomotive Stand Pipes, &c., &c.

Sizes 4 inches to 16 inches.



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The only positive Automatic Water Pressure Regulator in the market. We have never had a failure.

a.d.m.j.

Write for Lithotype, etc.

WESTINGHOUSE WATER METER.

ACCURATE.

SIMPLE IN CONSTRUCTION.

DURABLE.

LOW IN PRICE.

The dial made to indicate the measurement either in gallons or cubic feet as may be desired. All the claims which we make for this Water Meter will be fully sustained, and we invite Water Companies and Water Departments to make a personal examination and test of it, for which we will be pleased to furnish a reasonable number of meters on sixty days' trial, after which they may be paid for or returned.

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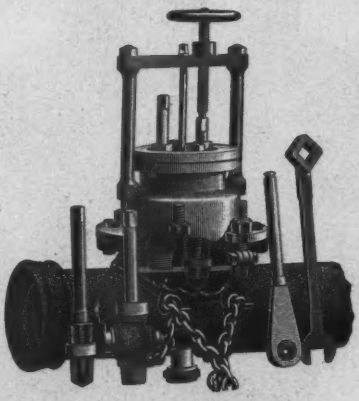
The Hall Tapping Machine.



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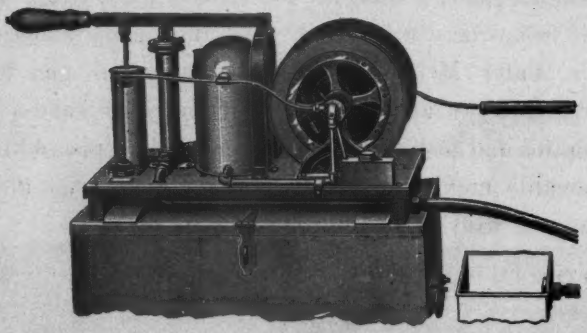

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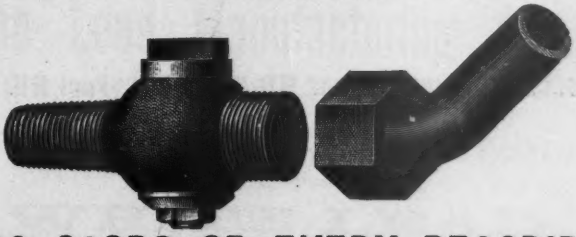

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Correspondence with Water Works solicited.

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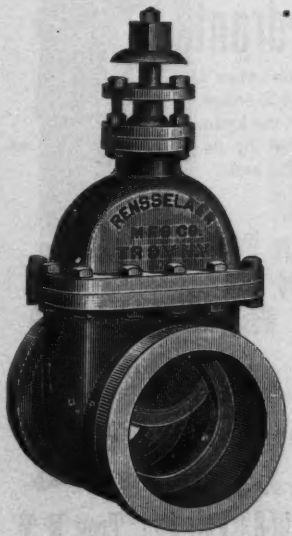

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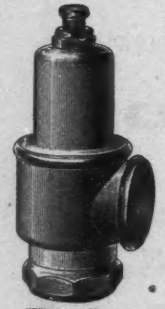

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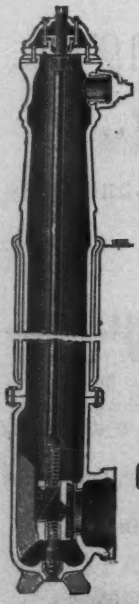

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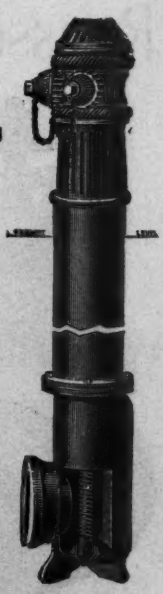

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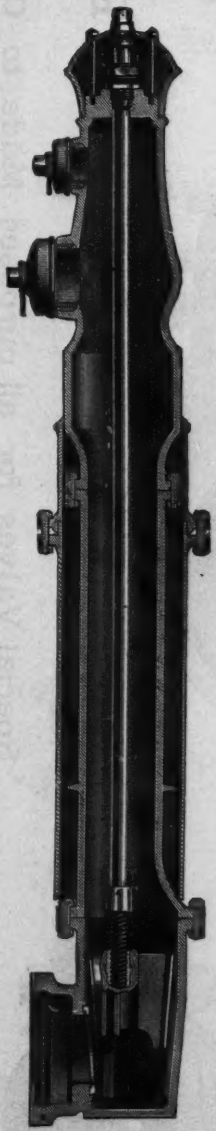

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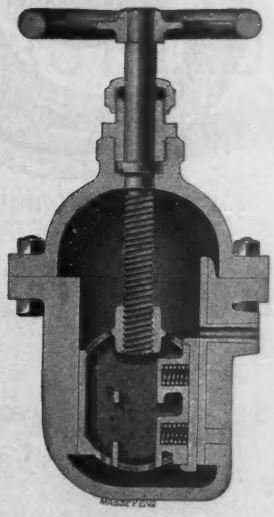

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ALL SIZES OF FLANGED PIPE

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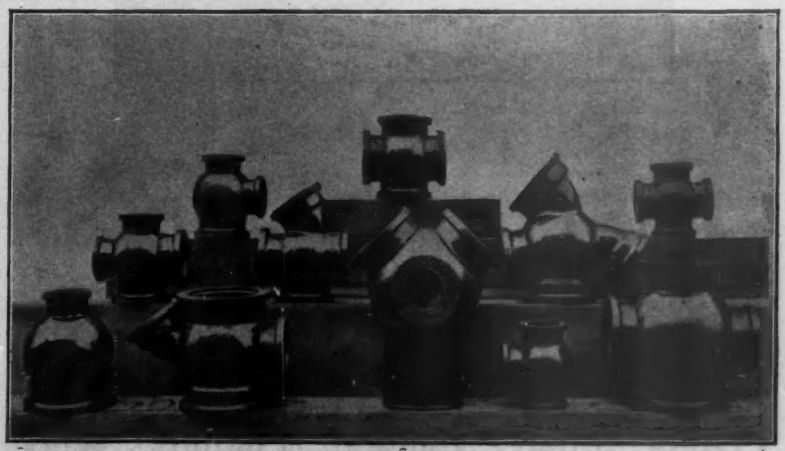
PROVIDENCE, R. I.

Globe Special Castings for Water Works.



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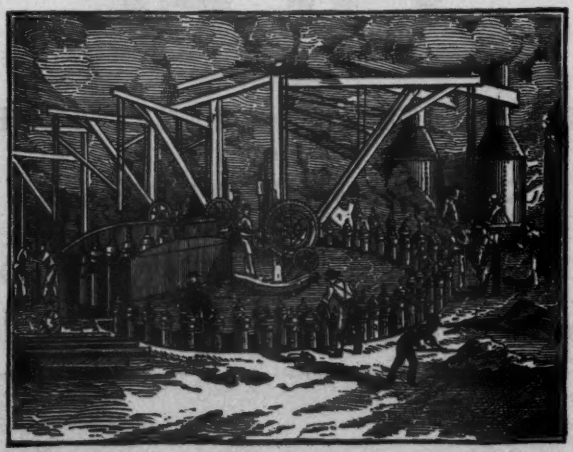

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OF HOLYOKE,

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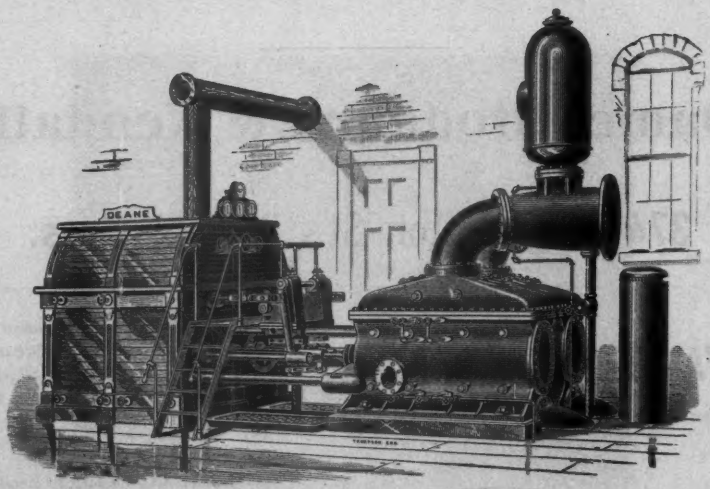

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Over 625,000,000 Gallons.

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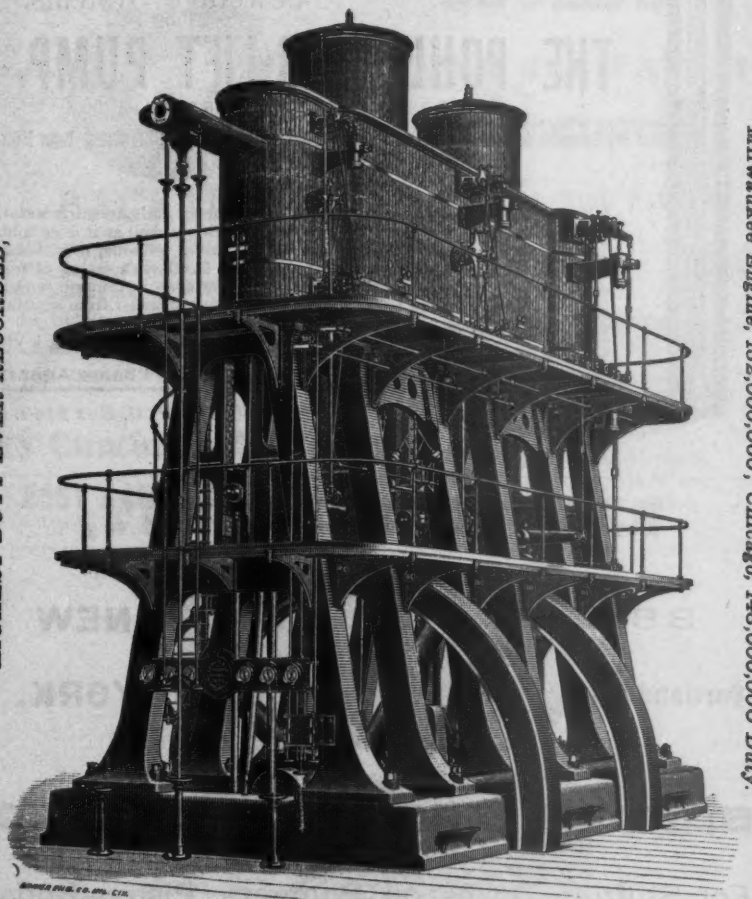

Milwaukee Engine, 152,000,000; Chicago, 148,000,000 Duty.

ALLIS TRIPLE EXPANSION ENGINE.

HIGH DUTY PUMPING ENGINES,

TRIPLE EXPANSION AND COMPOUND.

Special SEWAGE and DRAINAGE PUMPS.

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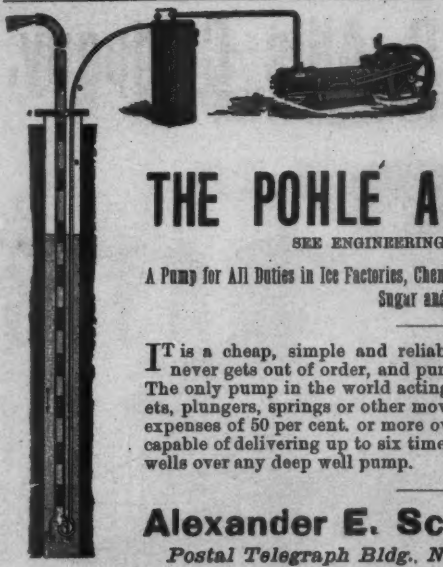

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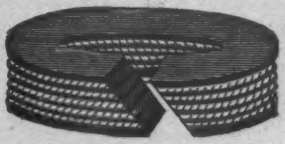

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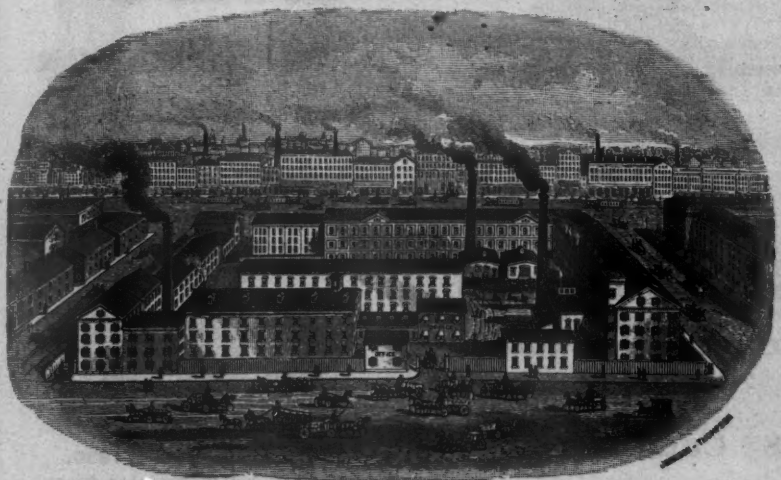

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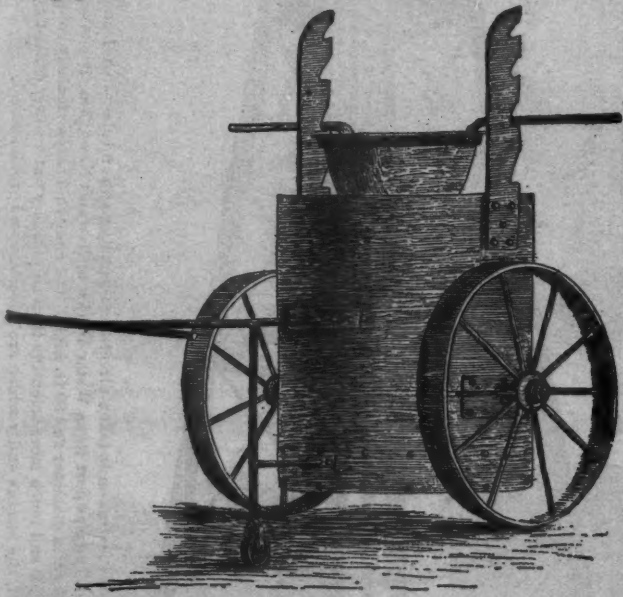

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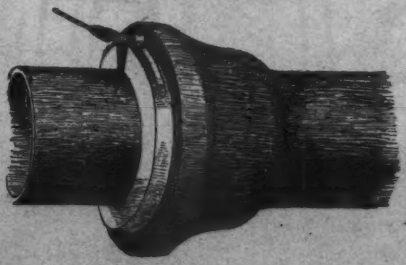

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